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Alaska Department of Fish and Game
Division of Commercial Fisheries
333 Raspberry Road
Anchorage, Alaska 99518

May 2002

Sonar Estimation of Fall Chum Salmon Abundance In the Sheenjek River, 2000

by

Louis H. Barton

State of Alaska Tony Knowles, Governor

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AUTHOR

Louis H. Barton is a Fishery Biologist with the Alaska Department of Fish and Game, Division of Commercial Fisheries, 1300 College Road, Fairbanks, AK 99701.

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ABSTRACT

A user non-configurable, fixed-location, side-looking sonar system was used to estimate chum salmon (*Oncorhynchus keta)* escapement in the Sheenjek River during the 36-day period 8 August through 12 September 2000. The sonar-estimated escapement of 18,652 chum salmon through 12 September was subsequently expanded to a total abundance estimate of 30,084 using mean run timing data from 1986-1999. This is 53% below the minimum escapement goal of 64,000 fish and the third lowest chum salmon escapement observed to this river. Although the sonar project terminated early in 2000, the entry pattern of chum salmon revealed a single mode, with peak passage occurring on 8 September. Daily upstream migration was primarily confined to periods of darkness or suppressed light with greatest movement (78%) occurring between 2000 and 0900 hours.

Range of ensonification was considered adequate for detection of the majority of fish passing the sonar site and most fish passing through the acoustic beam were nearshore oriented. However, the passage estimate should be considered conservative since it does not include fish passing beyond the counting range (including along the unensonified far bank), fish present before sonar equipment was in operation, or fish passing upstream after counting ceased. Variations in Sheenjek River water levels and velocities, together with migration behavior of upstream migrant chum salmon, can affect the ability of hydroacoustic equipment to enumerate salmon passage. However, these deviations were accounted for by regularly comparing sonar counter output to visual observations on an oscilloscope.

A newly purchased split-beam sonar system was operated over a two-week period at the Sheenjek River project site for experimental purposes in 2000.

KEY WORDS: Chum salmon, *Oncorhynchus keta,* sonar, hydroacoustics, escapement, enumeration, Yukon River, Porcupine River, Sheenjek River

INTRODUCTION

Although five species of anadromous Pacific salmon *Oncorhynchus* are found in the Yukon River drainage, chum salmon *O. keta* are the most abundant and occur in genetically distinct summer and fall runs (Wilmot et al. 1992; Seeb et al. 1995). Fall chum salmon are larger, spawn later, and are less abundant than summer chum salmon. They primarily spawn in the upper portion of the drainage in streams that are spring fed, usually remaining ice-free during the winter (Buklis and Barton 1984). Major fall chum salmon spawning areas occur within the Tanana, Chandalar, and Porcupine River systems, as well as portions of the upper Yukon River in Canada (Figure 1).

In-river Fisheries

Yukon River fall chum salmon are in great demand commercially and especially desired for subsistence use. Commercial harvest is permitted along the entire mainstem river in Alaska as well as in the lower portion of the Tanana River. No commercial harvest is permitted in any other tributaries of the drainage including the Koyukuk and Porcupine River systems. While commercial harvest also occurs in the Canadian portion of the Yukon River near Dawson, the majority of fish taken commercially occurs in the Alaskan portion of the lower river, downstream of the village of Anvik. Fall chum salmon use as a subsistence item is greatest throughout the upper river drainage, upstream of the village of Koyukuk.

Although the Alaskan commercial fishery for Yukon River fall chum salmon developed in the early 1960's, annual harvests remained relatively low through the early to mid-1970s. Estimated total in-river utilization (U.S. and Canada commercial and subsistence) of Yukon River fall chum salmon was below 300,000 fish per year prior to the mid-1970s (Table 1). However, in-river commercial fisheries became more fully developed during the late 1970's and early 1980's, with total utilization averaging 536,000 fish from 1979-1983. Harvest peaked in 1979 at 615,000 and in 1981 at 677,000 fish. Since the mid-1980's management strategies have been implemented to reduce commercial exploitation on fall chum stocks in order to improve upon low escapements observed throughout the drainage during the early 1980's. In 1987 a complete closure of the commercial fall chum fishery occurred in the Alaskan portion of the drainage, while in 1992 commercial fishing in Alaska was restricted to only a portion of the Tanana River during the fall season. In addition to a commercial fishery closure in 1993, that year marked the first in State history that a total river closure to subsistence fishing occurred in the Yukon River. The closure was in effect during the latter portion of the fall season in response to the extremely weak fall chum salmon run in that year.

Yukon River fall chum salmon runs improved somewhat from 1994 through 1996. While limited commercial fishing was permitted in the Alaskan portion of the upper Yukon and Tanana Rivers in 1994, commercial fishing was permitted in all districts throughout the Alaska portion of the drainage in 1995. However, in 1996 limited commercial fishing was permitted only in selected districts of the mainstem Yukon River, with none being permitted in the Tanana River.

Poor salmon runs to Western Alaska in 1997, 1998, and 1999 again resulted in partial or total closures to commercial fishing in the Alaskan portion of drainage. Commercial fishing was only permitted in the Tanana River in 1997, while a total commercial fishery closure was required in 1998. A very limited commercial harvest was permitted in 1999.

Escapement Assessment

During the period 1960 through 1980, only various segments of annual runs of Yukon River fall chum salmon were occasionally estimated from mark-and-recapture studies (Buklis and Barton 1984). Excluding these tagging studies and apart from aerial assessment of selected tributaries since the early 1970's, comprehensive escapement estimation studies were sporadic and limited to only two streams, the Delta River (Tanana River drainage) and the Fishing Branch River (Porcupine River drainage). However, comprehensive escapement assessment studies intensified on major spawning tributaries throughout the drainage subsequent to the early 1980s.

One of the most intensely monitored spawning streams during this period has been the Sheenjek River. Although escapement observations date back to 1960 when the USFWS reported chum salmon spawning in September, the best database consists of the 26-year period 1974-1999. Prior to 1981 escapement observations in the Sheenjek River were limited to aerial surveys flown in late September and early October (Barton 1984a). Subsequent to 1980, escapements were monitored annually using fixed-location, single-beam sonar systems (Barton 1982, 1983, 1984b, 1985, 1986, 1987, 1988, 1994, 1995, 1999, 2000). However, an early segment of the fall chum salmon run was not included by sonar counting operations from 1981 through 1990 due to late project startups centered around 25 August. By comparison, average startup during the period 1991 through 1999 was 8 August, more than two weeks earlier than in previous years. However, sonar-estimated escapements for the years 1986 through 1990 were subsequently expanded to include fish passing prior to sonar operations (Barton 1995). Termination of sonar counting has been more consistent over the years, averaging 25 September for the period 1981 through 1999. This report presents results of studies conducted in 2000.

Study Area

The Sheenjek River is one of the most important producers of fall chum salmon in the Yukon River. Located above the Arctic Circle, it heads in the glacial ice fields of the Romanzof Mountains, a northern extension of the Brooks Range, and flows southward approximately 400 km to its terminus on the Porcupine River (Figure 2). Although created by glaciers, the river has numerous clearwater tributaries. Water clarity in the lower river is somewhat unpredictable, but is generally clearest during periods of low water; water level normally begins to drop in late August and September. Upwelling ground water composes a significant proportion of the river flow volume, especially in winter, and it is in these spring areas that fall chum salmon spawn, particularly within the lower 160 km. The sonar project site is located approximately 10 km upstream from the mouth of the river. Annual escapement estimates averaged 91,000 spawners for the period 1986-1994 and approximately 123,000 spawners for the most recent 5-year period of 1995-1999. At present, there is a minimum biological escapement goal (BEG) of 64,000 fall chum salmon established for this river. This goal is based upon hydroacoustic assessment of the run during the period approximating 25 August through 25 September (Buklis 1993).

Objectives

The overall goal of the Sheenjek River fall chum salmon study in 2000 was to estimate timing and magnitude of adult salmon escapement for in-season management purposes, and monitor quality of the escapement from age, sex and size information collected from sampled portions of the run. A secondary goal was to lend support in testing a newly purchased split-beam hydroacoustic system. To accomplish these goals, the following specific objectives were identified:

- Document timing and magnitude of chum salmon escapement using fixed-location, side looking hydroacoustic techniques,

- Estimate age, sex and size composition of the spawning population from sampled portions of the escapement using a beach seine as the capture technique,

- Monitor selected climatological and hydrological parameters daily at the project site for use as baseline data, and

- Provide labor and logistical support, and receive preliminary training in use of a newly purchased split-beam hydroacoustic system for potential replacement of the existing single beam system.

METHODS

Hydroacoustic Equipment

A user non-configurable, fixed-location, side-looking fisheries hydroacoustic system developed by the Hydrodynamics Division of Bendix Corporation[2] was used to estimate chum salmon abundance in the Sheenjek River in 2000. Fish passage was monitored with a 1985-model transceiver and transducer deployed from a right-bank[3] point bar at the historic sonar site (Figures 3 and 4).

Bendix side-looking transducers have co-axial, circular cross-section narrow (2°) and wide (4°) beam dimensions. Sampling ranges for the narrow and wide beams are each variable to 30 m but designed for optimum performance at 18.3 m and 9.1 m, respectively. The transceiver can be operated on either the narrow or wide beam independently, or by alternating acoustic pulse transmissions between the two beams. In the latter mode (that used on the Sheenjek River) the narrow and wide beams monitor fish passage in the outer and inner halves of the sampling range, respectively.

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[2] Reference to trade names does not imply endorsement by the Alaska Department of Fish and Game.

[3] Reference to right or left bank is determined by looking downstream.

The transceiver maintains a record of the spatial distribution of fish estimates based upon distance of the acoustic target from the transducer. Fish estimates were tallied and stored into dynamic memory by 16 equal range intervals or sectors. A tape printout showing the number of tallies (counts) by sector was printed each hour. The transceiver was designed to alert the system operator of potential "debris counts" when 24 counts in any one electronic sector occur in a 35-second period. Under such conditions, a "debris" code appears on the printout tape next to the suspect counts for the sector and hour in which they occur. Examples of factors that can result in "debris counts" include passage of debris through the ensonified water column, driving rain, snowfall, misaimed beam toward river bottom or water surface, high density of fish passage, and holding or spawning fish. In addition, a "rock inhibit" feature was designed into this counter to facilitate the system operator in maintaining aim of the acoustic beam as close to the natural bottom substrate as possible.

While other operational characteristics of Bendix hydroacoustic systems and procedures can be found in Bendix Corporation (1978) and Ehrenberg (undated), it should be noted that the 1985-model transceiver used in 2000 was modified after production to allow the system operator to lower the pulse repetition rate to a level that would not have previously been possible. This alteration was to better accommodate relatively slow chum salmon swimming speeds (A. Menin, Hydroacoustic Consulting, Sylmar, California, personal communication). The modification increased the system operator's ability to reduce the degree of positive bias associated with over-counting.

Site Selection and Transducer Deployment

The modular aluminum substrate designed for use with Bendix sonar systems has not been used on the Sheenjek River since 1984, due to salmon avoidance problems observed in previous years when the substrate was used (Barton 1985). The relatively gentle-sloping river bottom at the historic counting location has facilitated not having to use the substrate. A detailed bottom profile was obtained after initial transducer placement at the counting location by stretching a rope across the river and measuring water depth with a pole every 3-m. The transducer was mounted on a pod made of galvanized steel water pipe (Barton 1997) and deployed from the right-bank point bar. The pod was secured in place with sandbags and designed to permit raising and lowering the acoustic beam by using the two riser pipes that extended above the water. Fine adjustments were made with the knurled knobs that attached the transducer plate to the pod. The transducer was deployed in water ranging from approximately 0.5 to 1.0 m in depth, and aimed perpendicular to the current along the natural gravel substrate. An attempt was made to ensure the transducer was deployed at locations where minimum surface water velocities did not fall below approximately 30-45 cm/s.

The system operator used an artificial acoustic target during deployment to ensure transducer aim was low enough to prevent salmon from passing undetected beneath the acoustic beam. The target, an airtight 250 ml weighted plastic bottle, was allowed to drift downstream along the river bottom and through the acoustic beam. Several drifts were made with the target in an attempt to pass it through each electronic sector of the counting range. When the transducer was properly aimed, the target appeared as a vertical deflection (spike) on an oscilloscope screen as it transected the acoustic beam at any given distance. The target may or may not have simultaneously registered a count (or multiple counts) on the sonar counter, depending upon the length of time it remained in the acoustic beam as it drifted downstream along the river bottom.

As in previous years, a fish lead was constructed shoreward from the transducer to prevent upstream salmon passage inshore of the transducer. Fish leads were constructed using 5 cm x 5 cm by 1.2-m high Tuflink-brand fencing and 2.5 m metal "T" stakes. Leads were constructed so as to include the nearfield "dead range" of the sonar transducer. Whenever a transducer was relocated because of rising or falling water level, the inshore lead was shortened or lengthened as appropriate, and the artificial target used to ensure proper re-aiming. A 5-m aluminum counting tower was also deployed near the transducer to facilitate visual and electronic calibrations when water conditions permitted.

Sonar Calibrations and Count Adjustments

Daily comparisons (termed calibrations) were made between oscilloscope observations and automated counter output to determine if the number of fish registered by the sonar counter equaled the number of fish observed passing through the acoustic beam. A minimum of six, 15- to 30-minute calibrations were targeted each day within the following time periods: 0001-0100 hours; 0300-0400 hours; 0600-0700 hours; 1100-1200 hours; 1600-1700 hours; and 2100-2200 hours. Duration of calibrations was based upon the following criteria: 1) stop calibration at 15 minutes if less than 10 fish are observed; and, 2) extend 15-minute calibration to 30 minutes if 10 or more fish are observed in the first 15 minutes.

Calibration results were used to adjust automated passage estimates on a daily basis for positive or negative bias. Adjustment periods were defined by the time between individual calibrations. An associated adjustment factor (*A*), specific to each adjustment period (*i*) was calculated as:

$$A_i = \frac{OC_i}{OS_i} \tag{1}$$

where:

OC_i = oscilloscope count; and,
SC_i = sonar count for adjustment period *i*.

Unadjusted hourly sonar passage estimates were multiplied by adjustment factors for each hour within the associated adjustment period. The resulting corrected hourly sonar estimates were summed, yielding the estimated daily passage ($\hat{D}$) of fall chum salmon, and is calculated as

$$\hat{D} = \sum (A_i SC_i \ ) \tag{2}$$

Sonar counts caused by fish other than salmon were assumed to be insignificant based upon historic test fishing records collected at the site. Counts identified as "debris" on printout tapes were deleted and replaced by linearly interpolated values prior to making adjustments. Linear interpolation was also used to estimate missing sector counts as a result of occasional printer malfunctions. Interpolated values for a given electronic sector were based upon registered counts for that sector in the preceding and following hour. Missing hourly blocks for a given day were estimated by extrapolation using seasonal average hourly passage rates from days when sonar functioned 24 hours.

Adjustments to the pulse repetition rate (PRR) or ping rate of the sonar counter were made to minimize over-counting (positive bias) or under-counting (negative bias). Over- or under-counting primarily results from changes in salmon swimming speeds that may be related to fluctuations in water level and velocity, photoperiod, or fish densities (Barton 1985, 1986, 1987, 1995). Although a few occasions arose when the ping rate was subjectively changed based upon a qualitative evaluation of fish passage rates, the ping rate was generally changed at the end of any calibration when the oscilloscope count exceeded 59 per hour and differed by more than 15% from the sonar count. The new ping rate was calculated as the sonar count divided by oscilloscope count, times the current PRR setting. If passage rates during calibrations on any given day never exceeded 59 fish per hour, the ping rate was changed at 2400 hours of that particular day. However, this change was made only if the sum of sonar counts during all of the day's calibrations differed from the sum of oscilloscope counts from all calibrations by more than 15%. Otherwise, the dial setting was left unchanged.

Test Fishing and Salmon Sampling

Region-wide standards have been set for the sample size needed to describe the age composition of a salmon population. These apply to the time period or stratum in which the sample is collected. Sample size goals are based on a one-in-ten chance (precision) of not having the true age proportion (pi) within the interval pi ± 0.05 for all i ages (accuracy).

Based upon age determination from scales, it has been established that a sample size of 160 fish per stratum is needed for chum salmon assuming two major age classes with minor ages pooled, and no unreadable scales. Since the preferred method of aging Yukon River fall chum salmon when in close proximity to their natal streams is from vertebrae collections, and allowing for 20% unreadable vertebrae, the Sheenjek River sample size goal was to sample approximately 30-35 chum salmon per week up to a maximum of 200. All length measurements on chum salmon were made to nearest 5mm and measured from mid-eye to fork-of-tail. Due to the sexual dimorphism in adult salmon as they near their natal spawning streams, sex determination was generally based upon external examination. However, whenever in question (and given that fish were sacrificed for vertebra collection), an incision was made along the ventral area of fish to examine gonads for positive sexual identification.

An adult salmon beach seine was periodically fished at different locations between the sonar site and approximately 10-12 km upstream to collect adult salmon for age, sex, and size composition. The beach seine (3-inch stretch measure) was 30 m in length by 55 meshes deep (~3 m). The seine was dyed green, constructed of #18 twine, possessed 3x5-inch high-density, non-grommet oval poly floats spaced approximately 45 cm apart, had a 115-120 lb lead line and 1/2 in (1.3 cm) float line.

Climatological and Hydrological Observations

A water level gauge was installed at the sonar site and monitored daily with readings made to the nearest centimeter. Instantaneous surface water temperature was measured daily with a pocket thermometer. Minimum and maximum air temperatures, maximum wind chill factor, and wind velocity and direction were measured daily with a Weather Wizard III weather station. Other daily observations included recording the occurrence of precipitation and estimating percent cloud cover. Climatological observations were recorded at approximately 1800 hours daily.

Logistical Support to Split Beam Sonar Feasibility Work

During the period 29 August and 9 September, on-site personnel for the Bendix sonar counting operations provided logistical support in testing of a newly purchased split-beam hydroacoustic system from Hydroacoustic Technology, Inc. (HTI) as a potential replacement for the Bendix single beam system. The field crew assisted in setting up and deployment of the new equipment, received hands-on operation/training of the split-beam system, and aided in dismantling and removal of the HTI equipment from site. Specific results of the HTI split-beam testing operation can be found in Pfisterer and Geiger (*In Prep*).

RESULTS

River and Sonar Counting Conditions

Location of transducer deployment in 2000 approximated the same place on the point bar used in most previous years. River bottom at the counting location sloped gently from the convex bank (right-bank, point bar) at a rate of approximately 5.4 cm/m (bottom slope ≈ 5%) to the shelf-break that lay approximately two-thirds of the way across the channel on 9 August (Figure 5). River width measured 62 m and much of the nearshore zone along the concave, left cutbank was cluttered with fallen trees and other woody vegetation. Water depth near the thalweg exceeded 3 m.

Relatively low water conditions prevailed at the sonar counting site in 2000. With respect to when the water gauge was first installed on 7 August, water level fell during the first week by an overall 21 cm. It remained at that level until 21 August, after which a 19 cm-rise occurred over the next two days. Subsequent to 23 August, water level had fallen 32 cm by 12 September and extremely shallow conditions were rapidly worsening in the lower river (Figure 6 and Appendix A). Although sonar counting could have likely continued for some days immediately at the project site, it was considered necessary to terminate early to ensure the project riverboats and equipment could be safely removed.

Fluctuations in water level affected placement of the transducer with respect to shore, and in turn the proportion of the river ensonified. The unensonified river zone measured from the cutbank approximated 20 m from 8 through 15 August, or approximately 31%. Subsequent to 15 August the unensonified zone was approximated 15 m or 26% of the river's width. Water temperature at the project site in 2000 ranged from 11°C on 11 August to 8°C on 12 September based upon instantaneous surface measurements (see Appendices A).

Abundance Estimation

The 2000 sonar-estimated escapement was 18,652 chum salmon for the 36-d period 8 August through 12 September (Table 2 and Appendix B). During the period of operation, sonar counts were adjusted daily for positive or negative bias based upon oscilloscope calibrations. A total of 194 calibrations averaging 19 minutes in duration were made (Appendix C). This approximated 62 hours or approximately 7% of the total number of hours the sonar counter was functional. An attempt was made to weight calibrations to periods of the day when upstream salmon migration was heaviest (Figure 7). For example, an average of 33% of the calibrations were made between 0001 and 0600 hours, corresponding to an average daily fish passage estimate of 43% for the same block of time. Similarly, an average of 15% of the calibrations were made between 1200 and 1800 hours, corresponding to an average daily fish passage estimate of 13% for that period of time.

Temporal and Spatial Distribution

Very few chum salmon were present in the river when sonar counting was initiated on 8 August as evidenced by only 42 fish estimated passing the project site. Daily passage estimates remained low through termination of the project, averaging only 518 fish per day. Although the sonar project ended early in 2000, the entry pattern of chum salmon exhibited a single mode with peak passage (~1,500) observed on 8 September (Figure 8). An estimated 726 chum salmon passed the project site on 12 September, the final day of sonar sampling.

The diel pattern in migration of Sheenjek River chum salmon typically observed in most years was again manifested in 2000 (Figure 9 and see Appendix B). Upstream migration was heaviest in periods of darkness or suppressed light, with fish moving in greater numbers close to shore. On average, greatest passage was observed between the hours of approximately 2000 and 0900 of the following day (~78%), with the peak occurring between the hours of 0300 to 0500 (~16%). With ensuing hours of daylight, upstream migration lessened and fish moved farther from shore. The period of least movement in 2000 occurred between approximately 0900 and 2000 hours (< 22%).

For the most part, migrating chum salmon were shore-oriented, passing through the nearshore sectors of the acoustic beam. Although a bimodal pattern was manifest in the spatial distribution of sonar counts, approximately 97% of the fish counted were estimated passing through the first ten electronic sectors, or within approximately 20 m of the transducer (Figure 10). Less than 1% was observed passing in the outer-most sectors (sectors 12 through 16). Approximately 37% of the counts occurred in the first 4 sectors and 42% in the middle sectors (7 through 10). The bimodal nature in spatial distribution of fish across the acoustic sampling range can be partially explained by a shift in fish movement away from shore during daylight hours.

Age-Sex-Size Composition

Estimation of salmon abundance received the highest priority at the Sheenjek River project site. Although an attempt was made to collect age, sex and size information in 2000, no salmon samples were obtained due to the weak chum salmon run, and the requirement that ages be determined from vertebrae.

DISCUSSION

The 2000 sonar-estimated escapement of chum salmon in the Sheenjek River is considered conservative because it does not include fish that passed the site before or after sonar sampling, nor does it include fish that passed beyond the range of the acoustic beam, including along the unensonified far bank. Drift gillnetting results during the period 1981-1983 at the historic sonar sampling site demonstrated that distribution of upstream migrant chum salmon was primarily confined to the right side of the river, with only a small (but unknown) proportion passing beyond the sonar counting range (Barton 1982, 1983, 1984b). Barton (1985) further hypothesized from investigations in 1984 that although dispersed throughout the river well below the sonar site, upstream-migrant chum salmon orient toward the right bank before reaching the sonar sampling location due to physical and hydrological conditions of the river at that location.

While no attempt was made to estimate fish passage in the unensonified river zone in 2000, it is believed to have been comparatively small based upon a review of the spatial distribution of fish by electronic sector. There was some question however, that perhaps a larger than usual passage of fish moving upstream undetected through the outer sectors of the ensonified water zone may have occurred in 2000 due to the lower than normal water conditions encountered; this being a function of transducer placement and active counting range in relation to where the shelf break was located. The question centered on whether or not a substantial (or greater than usual) number of fish may have passed undetected beneath the sonar beam where it extended beyond the shelf break. However, limited data collected with the split-beam sonar system at the project site in 2000 suggested this was not likely a major source of error. Pfisterer and Geiger (*In Prep*) concluded from limited data collected over a 25-hour period on 5-6 September with the split-beam counter, that only 11 valid upstream targets were observed with an offshore transducer that was placed so as to ensonify the deeper water beyond the shelf break, to the thalweg. During the same period, in excess of 940 fish were estimated passing through the near shore zone by the Bendix sonar counter. These limited data suggest that no more than approximately 1% of upstream targets may have passed undetected.

Although sonar has been used to monitor chum salmon escapements in the Sheenjek River since 1981, only since 1991 have estimates been obtained for comparable time periods i.e., for the period approximating 8 August through 25 September (Barton 1999). However, Barton (1995) used Run timing data collected from the nearby Chandalar River to expand Sheenjek River run size estimates for the years 1986-1988 and 1990 to a comparable time period, while the 1989 estimate was expanded based upon aerial survey observations made prior to sonar operations in that year

(Appendix D). Based upon average run timing data for 1986-1999, approximately 85% of the Sheenjek River fall chum salmon run (through the end of September) materializes subsequent to 24 August, with the central half of the run passing from 30 August through 17 September (Appendix E). The historical median day of passage is 8 September. Ending early on 12 September in 2000, after operating for only 36 days, the cumulative abundance estimate was 18,652 chum salmon. Estimating from Appendix E that an average of 62% of the run on the average should be present by 12 September, places a total escapement estimate for the Sheenjek River at 30,084 chum salmon.

Barton (1995) pointed out that sonar-estimated escapements in the Sheenjek River should be viewed in context with dates of project operation (Table 2), and that the BEG be considered a minimum-desired number of chum salmon passing the sonar site subsequent to 25 August. The escapement estimate in 2000 approximated only 30,084 chum salmon after being expanded for the early termination on 12 September. This is 53% below the minimum escapement goal of 64,000 chum salmon. Estimated escapement subsequent to 25 August approximated only 25,124 chum salmon, or 84% of the total estimate. This is the third lowest escapement observed to this river since inception of sonar counting operations in 1981 (Figure 11), and is considered a total run failure given the major parent year escapement levels of 241,900 in 1995 (returning age-5 fish) and 246,900 in 1996 (returning age-4 fish).

The poor escapement estimate to the Sheenjek River was consistent with escapement trends for other Yukon River areas. Escapement in the Chandalar River was estimated at 65,900 chum salmon for the 50-d period of 8 August through 26 September (Osborne and Melegari, *In Press*). The median day of passage was recorded on 5 September, with the central half of the run observed between 28 August and 15 September. This escapement estimate (using split beam sonar) was 26% lower than the 1999 estimate (88,700 fish) and 61% below the 1995-1999 average of 170,700 chum salmon--the only other years when split beam sonar was used in this river. No fall chum salmon escapement goal has been established for the Chandalar River.

Low numbers of returning fish were also reported in the Canadian portion of the Yukon River drainage in 2000. In the Fishing Branch River only 5,000 chum salmon passed the Department of Fisheries and Oceans weir during the 47-d period of 28 August through 13 October (JTC 2001). This was the lowest escapement on record and 90% below the minimum escapement goal of 50,000 fish. It is also considered a total run failure. The 2000 estimate of spawning escapement for Canadian upper Yukon River fall chum salmon was 55,362 fish, 31% below the minimum escapement goal of 80,000 chum salmon (JTC 2001).

Timely reporting of daily passage estimates at the Sheenjek River project site corroborated other in-season indicators that the 2000 Yukon River fall chum salmon run was extremely weak. No fall chum salmon BEG was achieved throughout the drainage and escapements to most areas were among the poorest on record; continuing a trend of very low salmon runs to some western Alaska river systems. Fall chum salmon runs in the Porcupine and Tanana Rivers were considered total failures, given the large parent year escapements in these drainages in 1995 and 1996.

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Table 1. Alaskan and Canadian total utilization of Yukon River fall chum salmon, 1961-2000. (Taken from JTC, 2001).

Year	Canada [a]	Alaska [b,c]	Total
1961	9,076	144,233	153,309
1962	9,436	140,401	149,837
1963	27,696	99,031 [d]	126,727
1964	12,187	128,707	140,894
1965	11,789	135,600	147,389
1966	13,192	122,548	135,740
1967	16,961	107,018	123,979
1968	11,633	97,552	109,185
1969	7,776	183,373	191,149
1970	3,711	265,096	268,807
1971	16,911	246,756	263,667
1972	7,532	188,178	195,710
1973	10,135	285,760	295,895
1974	11,646	383,552	395,198
1975	20,600	361,600	382,200
1976	5,200	228,717	233,917
1977	12,479	340,757	353,236
1978	9,566	331,250	340,816
1979	22,084	593,293	615,377
1980	22,218	466,087	488,305
1981	22,281	654,976	677,257
1982	16,091	357,084	373,175
1983	29,490	495,526	525,016
1984	29,267	383,055	412,322
1985	41,265	474,216	515,481
1986	14,543	303,485	318,028
1987	44,480	361,663 [d]	406,143
1988	33,565	319,677	353,242
1989	23,020	518,157	541,177
1990	33,622	316,478	350,100
1991	35,418	403,678	439,096
1992	20,815	128,031 [e]	148,846
1993	14,090	76,925 [d,f]	91,015
1994	38,008	131,217	169,225
1995	45,600	415,547	461,147
1996	24,354	238,686	263,040
1997	15,580	154,479 [e]	170,059
1998	7,901	62,869 [d]	70,770
1999	19,506	110,369 [g]	129,875
2000	9,236	18,920 [d,f]	28,156
Average			
1961-89	17,787	300,598	318,385
1990-99	25,489	203,828	229,317
1996-00	15,315	117,065	132,380

[a] Catch in number of salmon. Includes commercial, Aboriginal, domestic and sport catches combined.

[b] Catch in number of salmon. Includes estimated number of salmon harvested for commercial production of salmon roe.

[c] Commercial, subsistence, personal-use and ADF&G test fish catches combined.

[d] Commercial fishery did not operate in Alaskan portion of drainage.

[e] Commercial fishery operated only in District 6 (Tanana River).

[f] Subsistence fishery closure.

[g] Commercial fishery operated only in lower Yukon fishing districts.

Table 2. Operational dates of sonar sampling in the Sheenjek River for the period 1981-2000.

Year	Starting Date	Ending Date	Project Duration	Sonar Estimate	Expanded Estimate
1981	31-Aug	24-Sep	25	74,560	
1982	31-Aug	22-Sep	23	31,421	
1983	29-Aug	24-Sep	27	49,392	
1984	30-Aug	25-Sep	27	27,130	
1985	02-Sep	29-Sep	28	152,768	
1986	17-Aug	24-Sep	39	83,197 [a]	84,207
1987	25-Aug	24-Sep	31	140,086	153,267
1988	21-Aug	27-Sep	38	40,866	45,206
1989	24-Aug	25-Sep	33	79,116	99,116
1990	22-Aug	28-Sep	38	62,200	77,750
1991	09-Aug	24-Sep	47	86,496	
1992	09-Aug	20-Sep	43	78,808	
1993	08-Aug	28-Sep	52	42,922	
1994	07-Aug	28-Sep	53	150,565	
1995	10-Aug	25-Sep	47	241,855	
1996	30-Jul	24-Sep	57	246,889	
1997	09-Aug	23-Sep	46	80,423	
1998	17-Aug	30-Sep	45	33,058	
1999	10-Aug	24-Sep	46	14,229	
2000	08-Aug	12-Sep	36	18,652 [b]	30,084
Averages:					
1981-85	30-Aug	24-Sep	26	67,054	
1986-90	21-Aug	25-Sep	36	81,093	91,909
1991-99	08-Aug	25-Sep	48	108,361	
2000	08-Aug	12-Sep	36	18,652	30,084

[a] The sonar-estimated escapement in these years was subsequently expanded to include fish passing prior to sonar operations (Barton 1995). Expansions for 1986-1988 and 1990 were based upon run timing data collected in the nearby Chandalar River. The 1989 estimate was expanded based upon aerial survey survey observations made in the Sheenjek River prior to sonar operations in that year.

[b] The sonar-estimated escapement in 2000 was expanded to include fish passing subsequent to 12 September when the project ended early due to low water. Expansion was based upon average run timing observed for years 1986-1999.

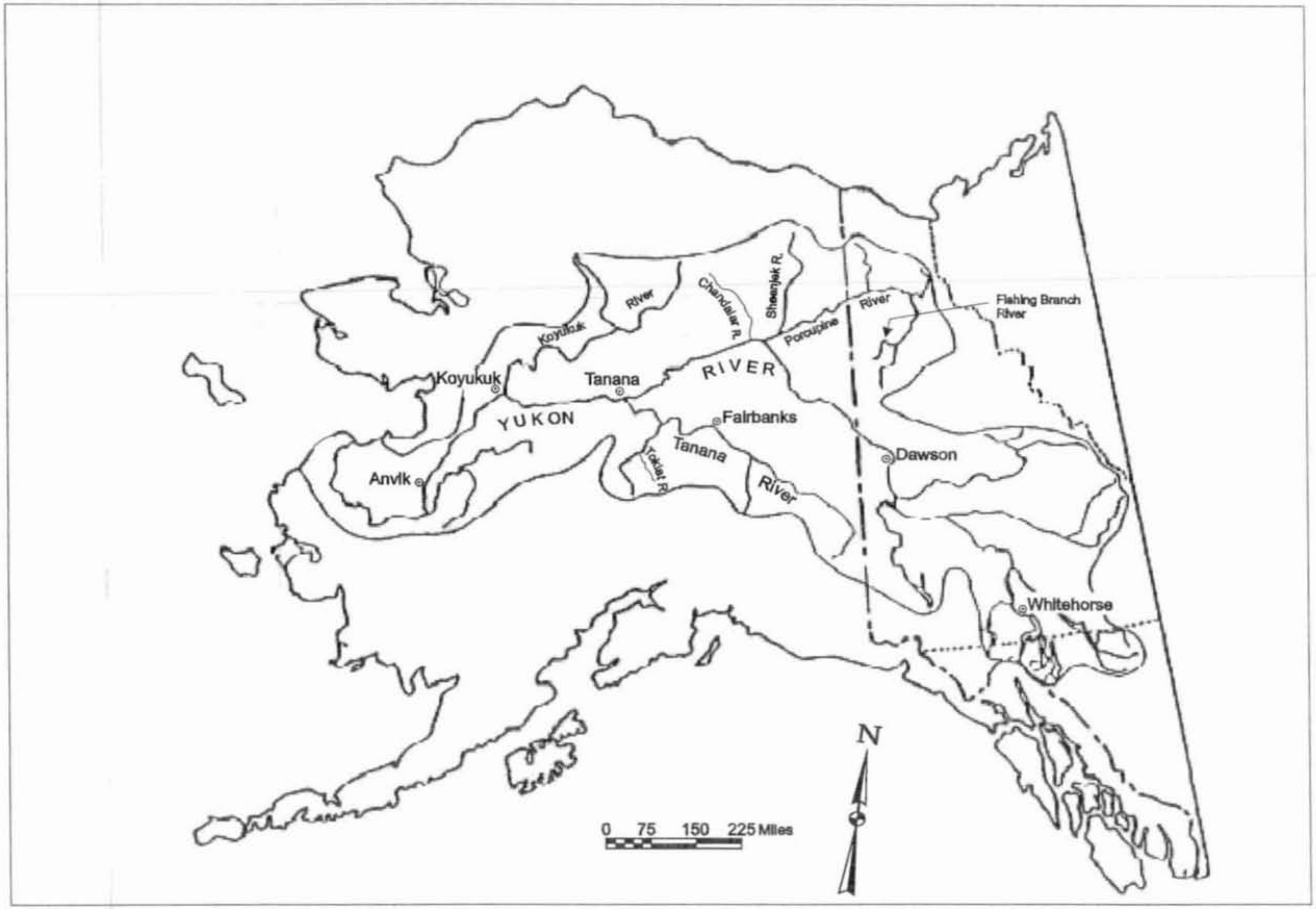


Figure 1. The Yukon River drainage showing selected locations.

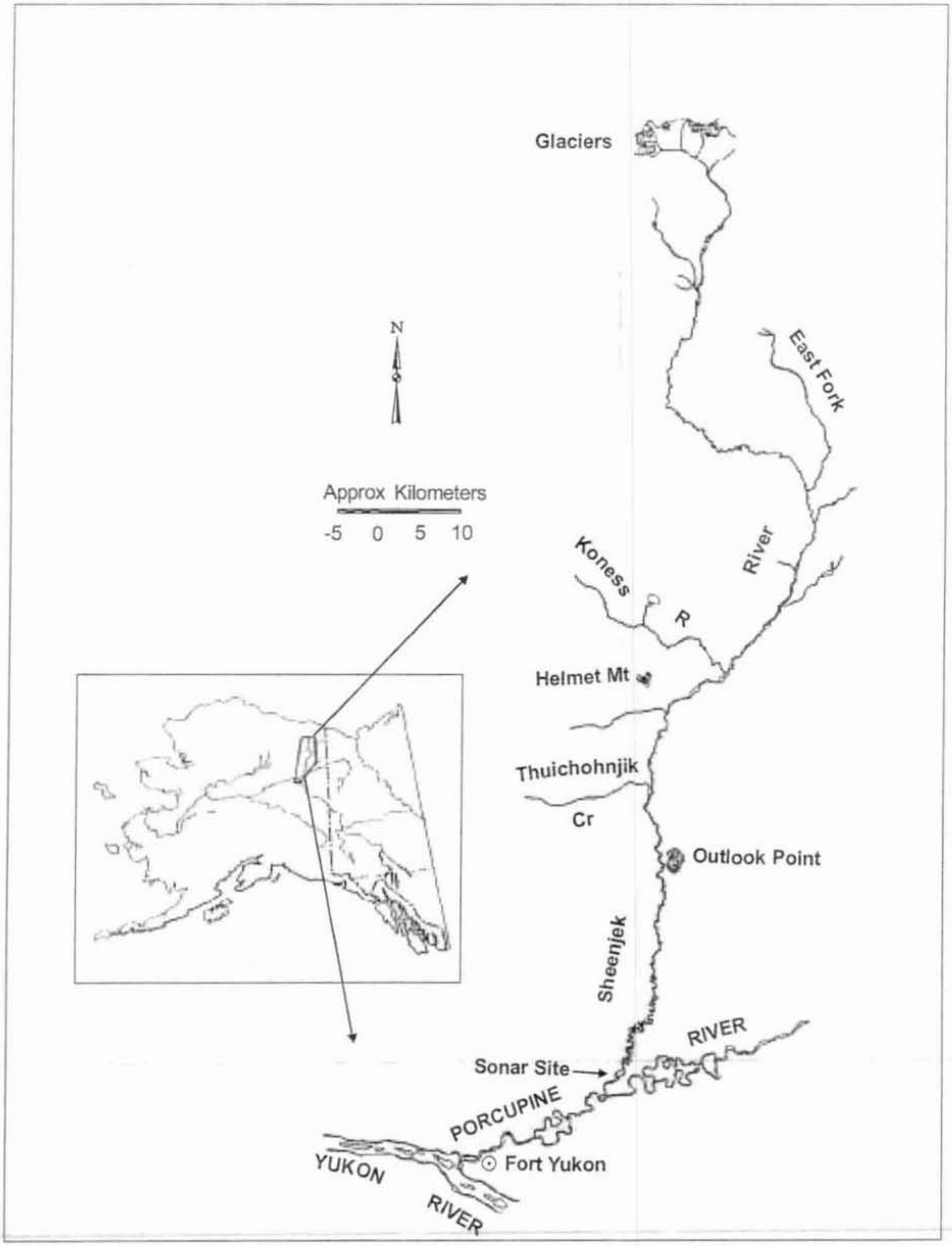


Figure 2. The Sheenjek River drainage.

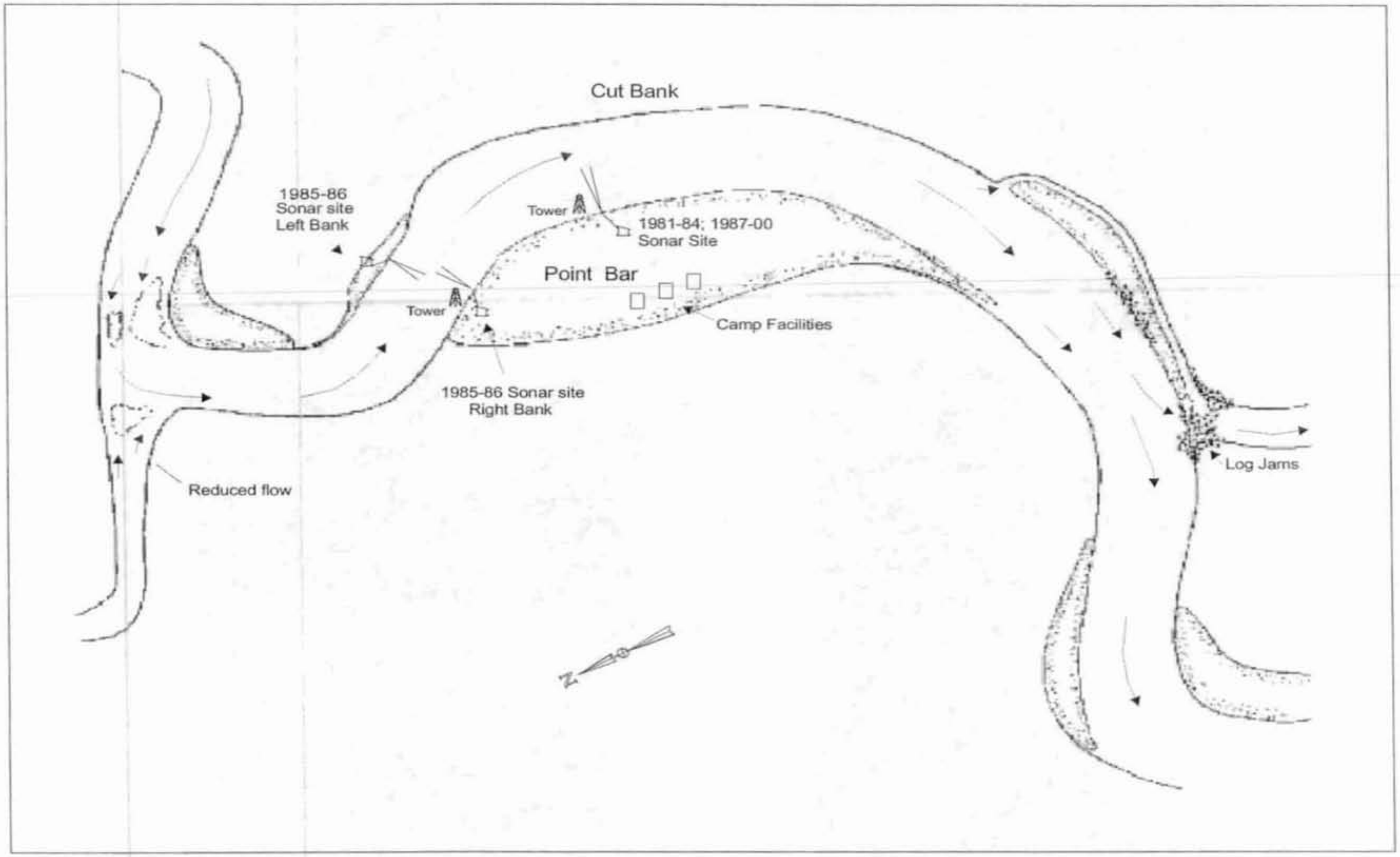
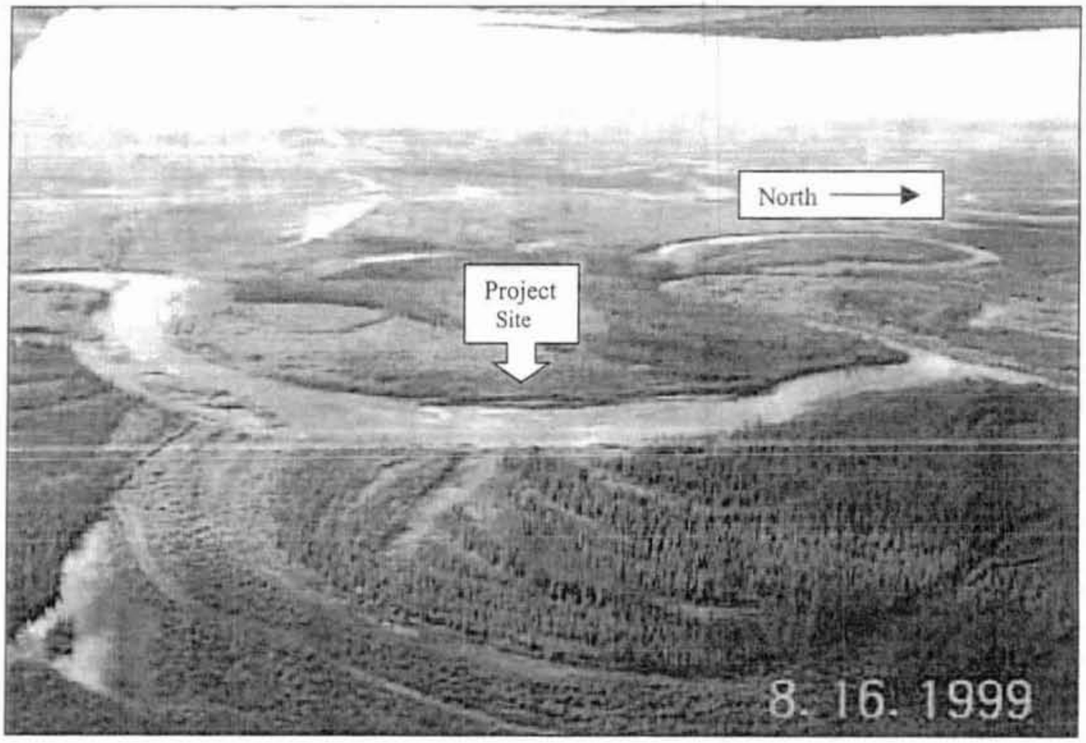


Figure 3. The Sheenjek River sonar project site.



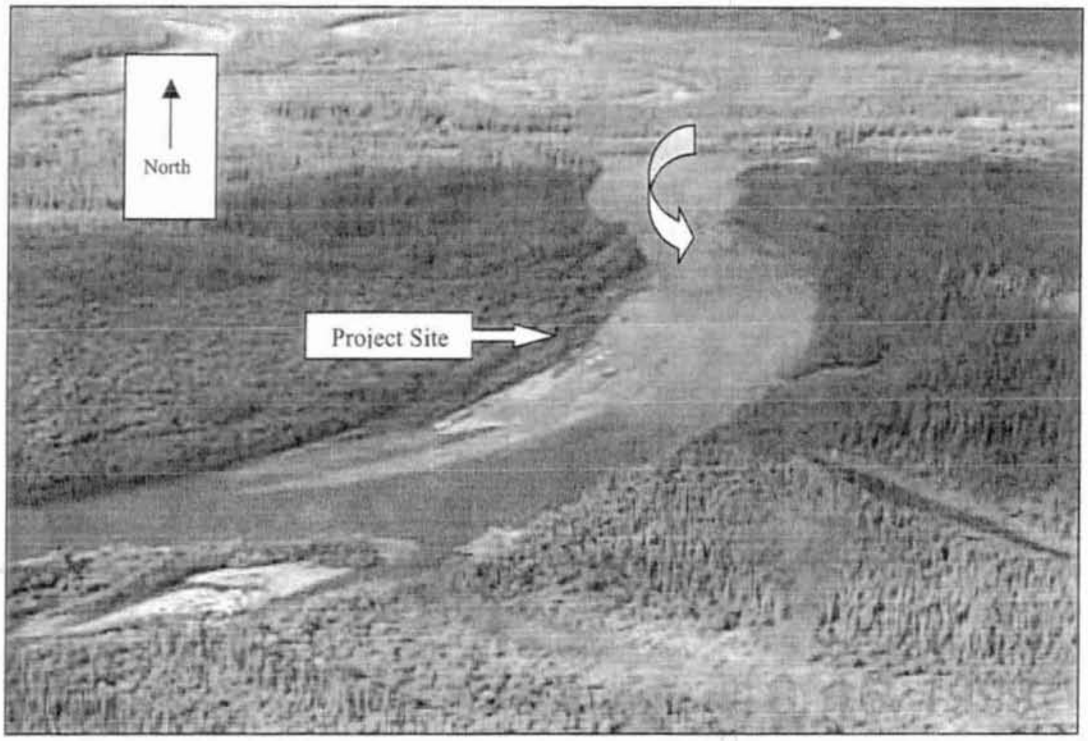


Figure 4. Aerial photographs of the Sheenjek River sonar project site taken 16 August 1999.

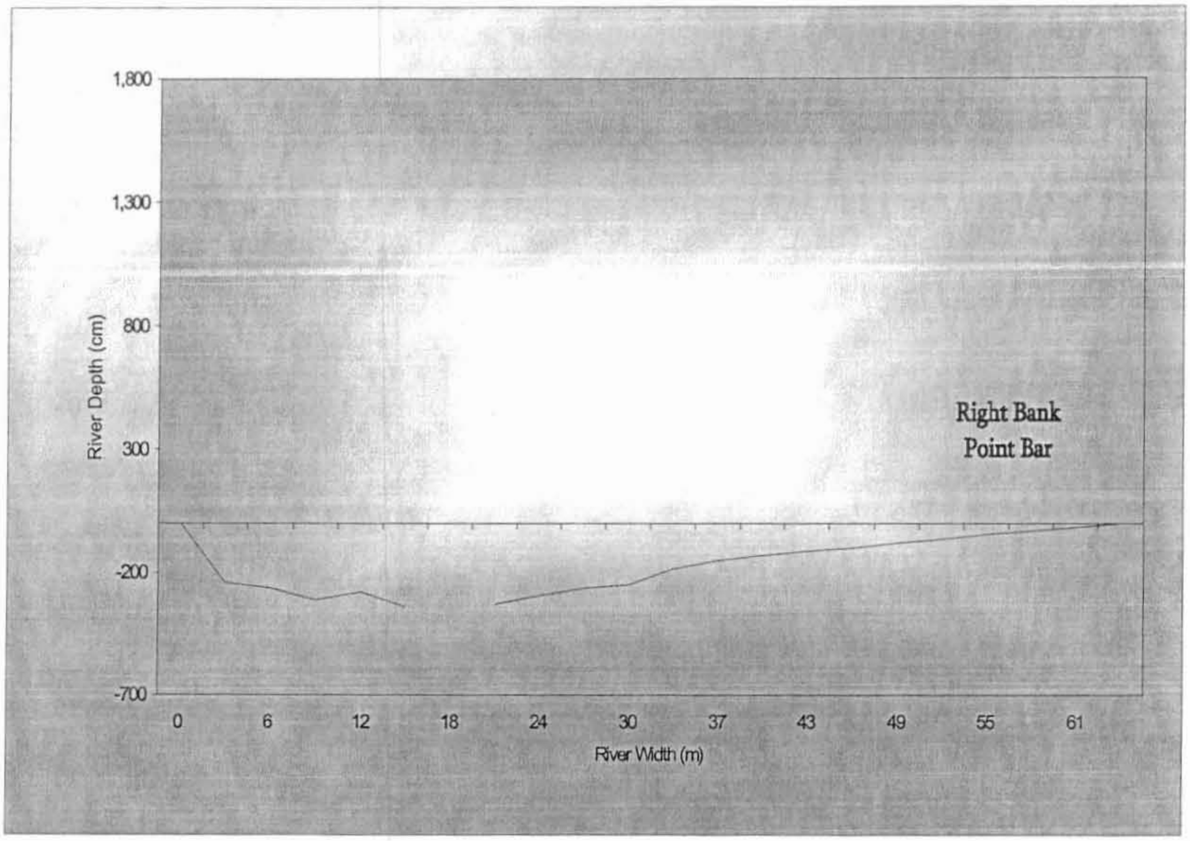


Figure 5. Depth profile (downstream view) made 9 August at the Sheenjek River sonar project site, 2000.

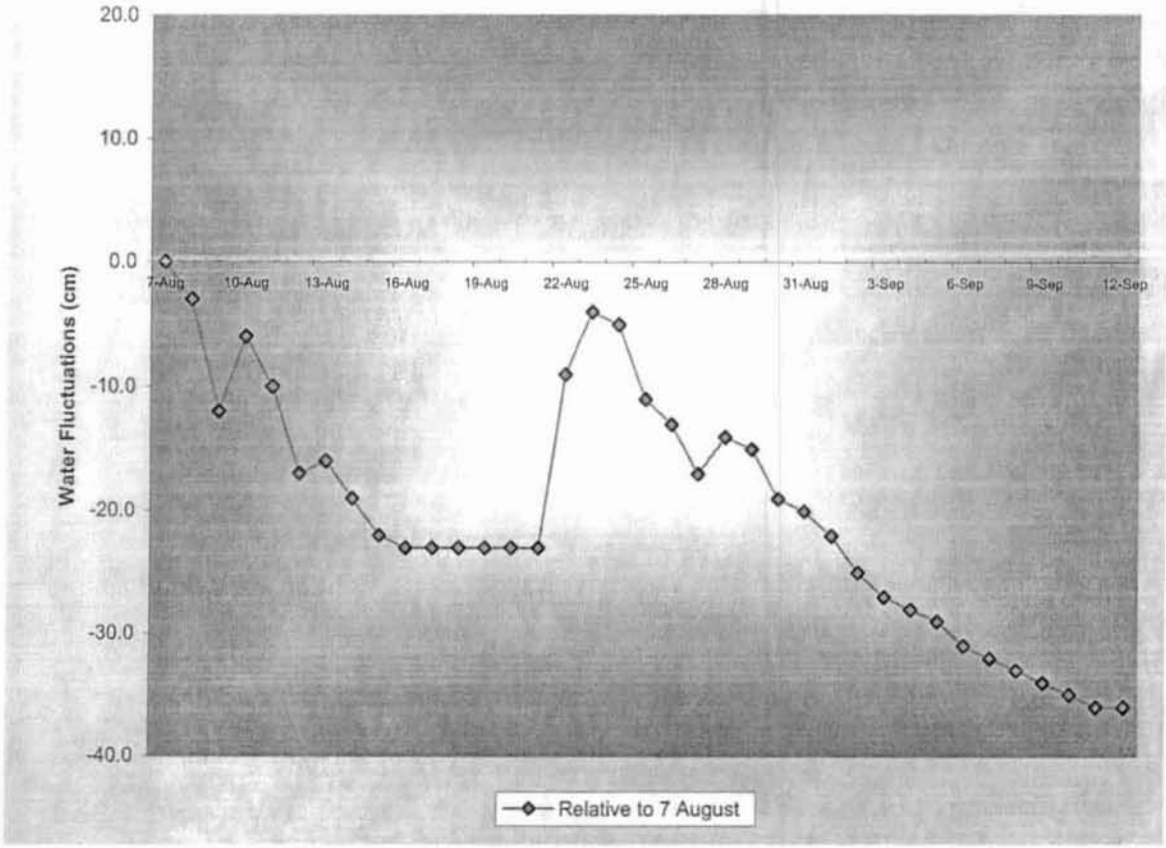


Figure 6. Changes in daily water elevation relative to 7 August measured at the Sheenjek River project site, 2000.

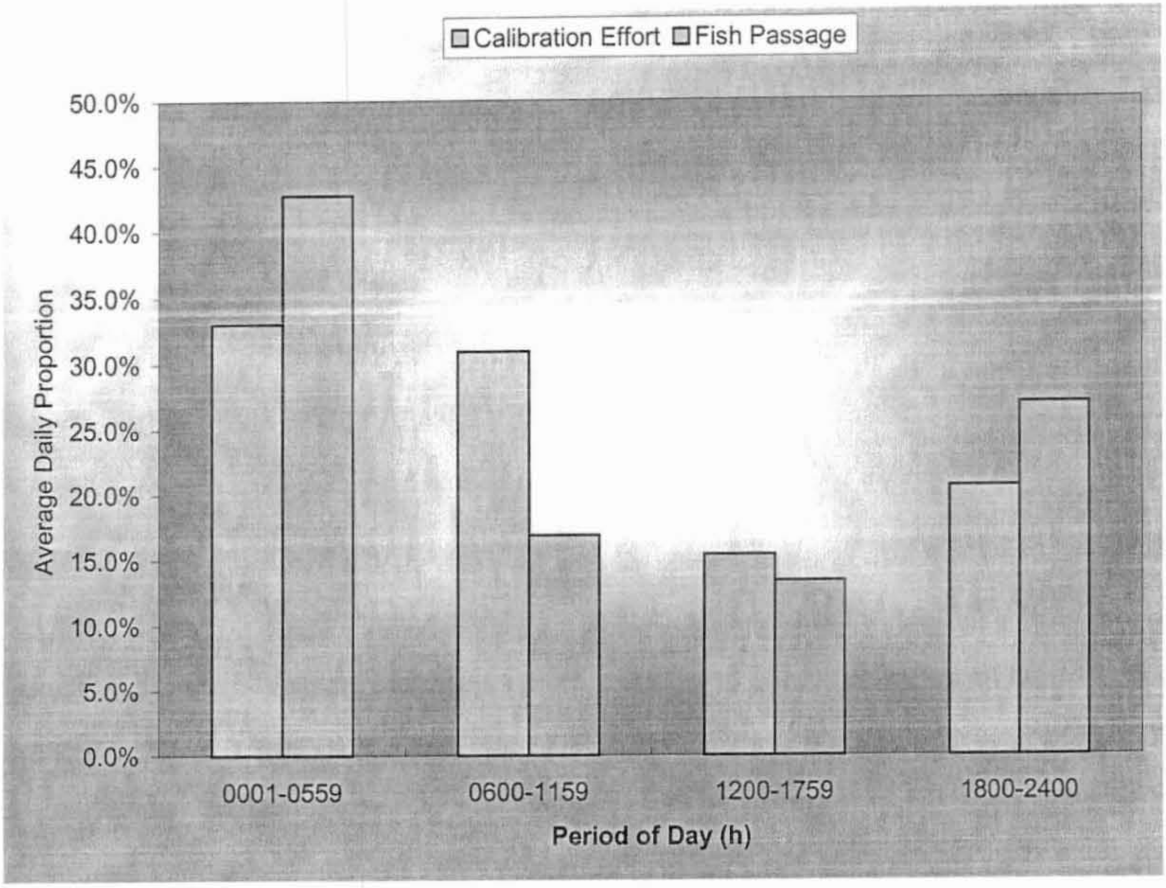


Figure 7. Comparative average sonar calibration effort versus average fish passage in the Sheenjek River, 2000.

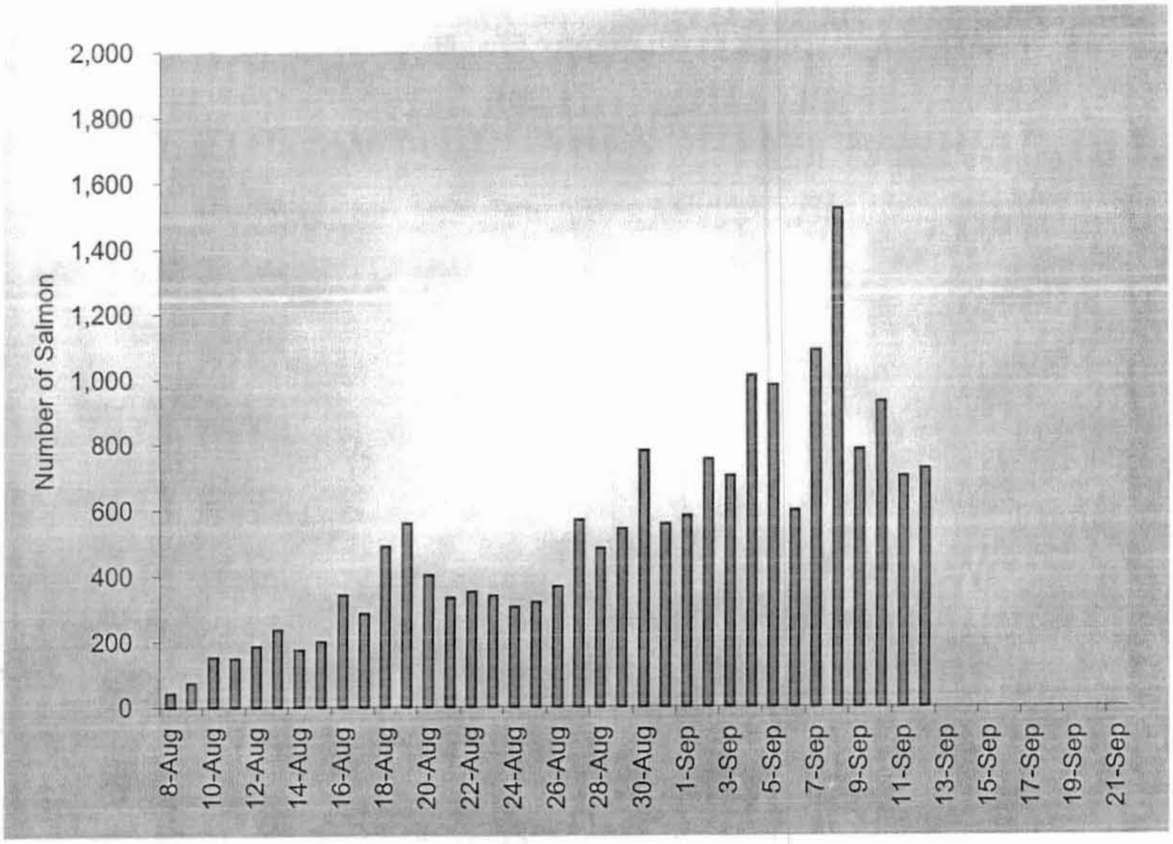


Figure 8. Adjusted sonar counts attributed to fall chum salmon by date, Sheenjek River, 2000.

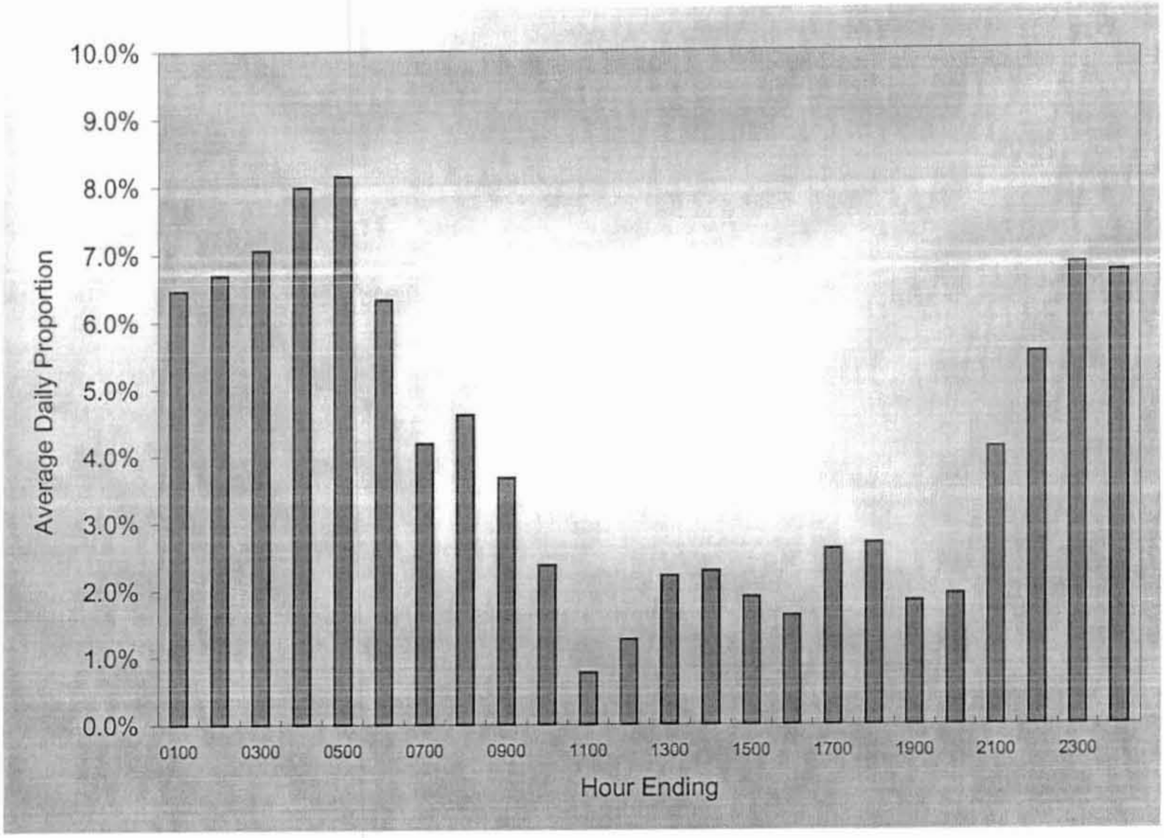


Figure 9. Temporal migration pattern of fall chum salmon observed in the Sheenjek River, 8 August through 12 September 2000.

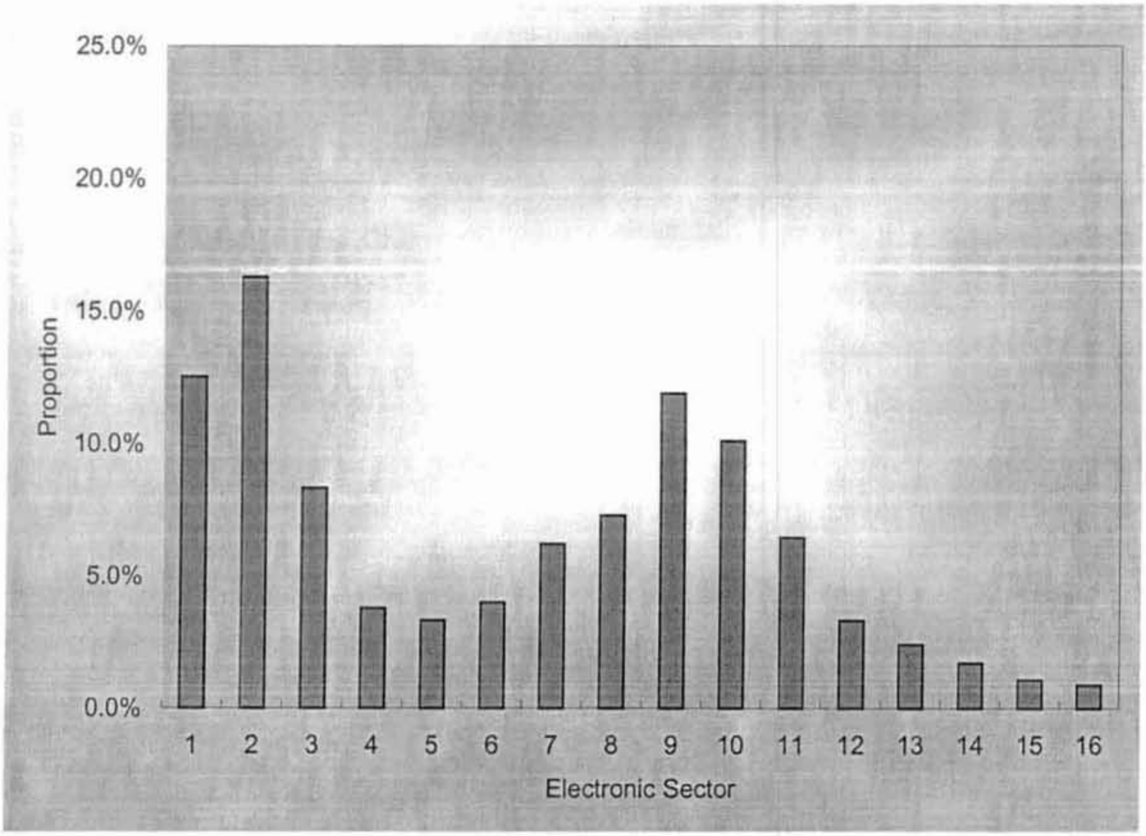


Figure 10. Average distribution of sonar counts by electronic sector attributed to fall salmon in the Sheenjek River, 2000.

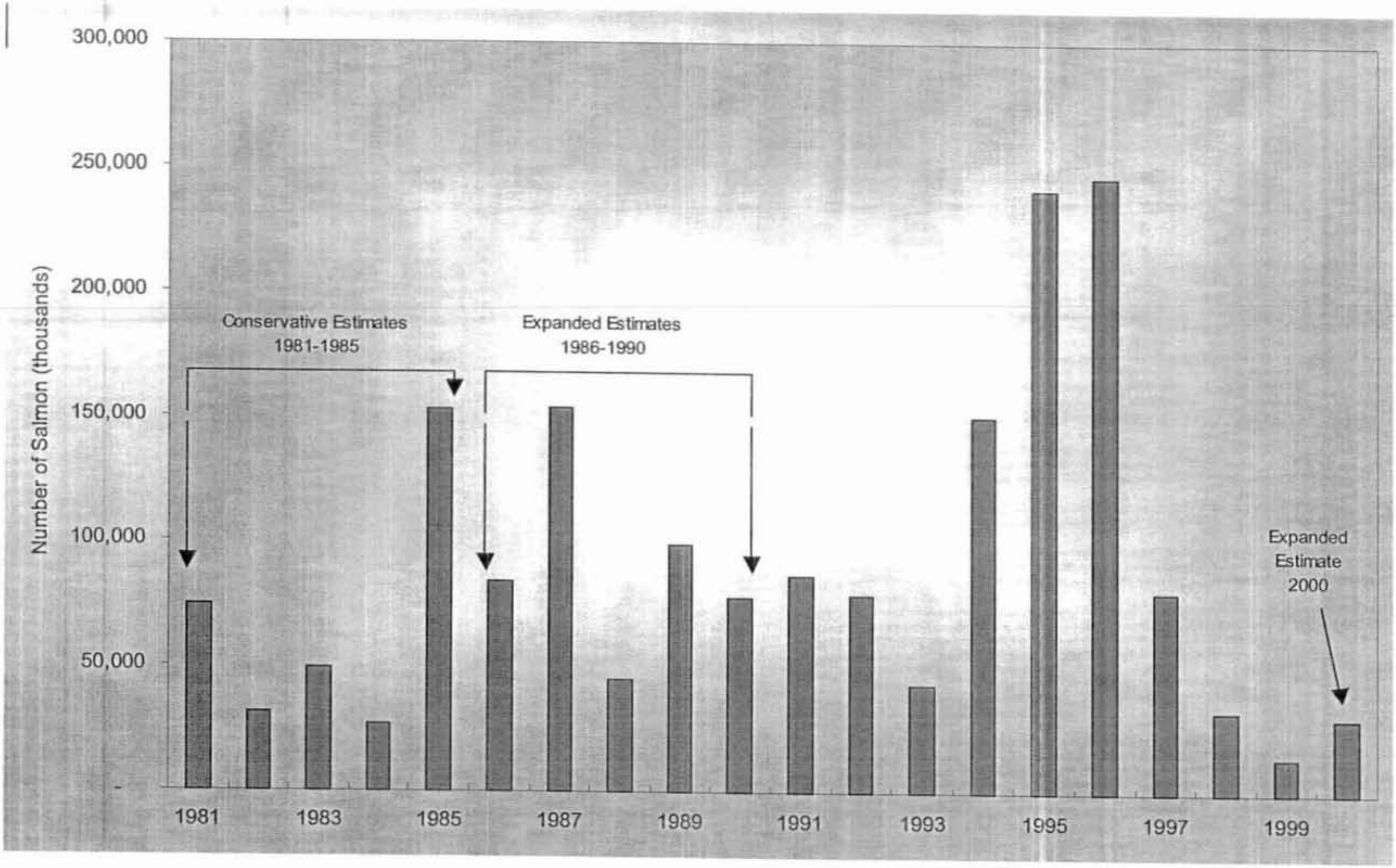


Figure 11. Sonar-estimated escapement of fall chum salmon in the Sheenjek River, 1981-2000.

Appendix A. Climatological and hydrological observations and miscellaneous comments made at the Sheenjek River project site, 2000.

Date	Calibration Start Time	Precipitation (code)[a]	Cloud Cover (code)[b]	Wind: Current Azmuth and speed (mph)	Wind: Maximum (mph)	Wind: Maximum Time	Temperature (C°): Water Surface	Temperature (C°): Air Min	Temperature (C°): Air Max	Temperature (C°): Air Wind Chill	Water Level (cm): ± 24 h Change	Water Level (cm): relative to zero datum	Water Color (code)[c]	Remarks
06-Aug		A												Finalize setting up camp.
07-Aug		A	C								zero datum	0	B	Barton/Lingnau arrive; sound river in several places; install water gauge - zero datum @ 33 cm.
08-Aug	0900	A		SW							-3.0	-3	B	Install 1985 sonar ctr and fish lead; review sonar OP's in detail with crew; breezy - water falling
09-Aug	1800	A	B	180° @ 1							-9.0	-12	B	Made detailed profile; install weather sta; review PC data recording with crew; found mammoth tooth
10-Aug	1800	B	O	200° @ 7	20	1543		8	18	13	6.0	-6	B	Water still falling; very few fish passing; Barton/Lingnau departed.
11-Aug	1900	A	B	210° @ 1	17	0858	11	9	17	9	-4.0	-10	B	Adjust xducer aim.
12-Aug	1140	B	B	200° @ 2-3	9	0919	11	7	16	11	-7.0	-17	B	Noticing more sticks and branches in weir.
13-Aug	2000	C	O	0° @ 6	16	1958	11	10	17	8	1.0	-16	B	Little evidence of salmon passing; light to heavy intermittent rain off/on today.
14-Aug	1810	E	O	30° @ 12	23	1757	9.5	2	6	-4	-3.0	-19	B	Stout north wind and cold; wind chill 23-31 F; snowed several times today.
15-Aug	1900	A	C	50° @ 3	24	1821	9	1	18	9	-3.0	-22	B	Sunny, windy and chilly day; full moon tonight.
16-Aug	1830	A	C	190° @ 1	8	1505	9.5	-1	25	23	1.0	-21	A	Moved xducer out about 4 m; extended fish lead; attempt tower counting.
17-Aug	1900	A	B	230° @ 1	12	1434	10	-1	23	14	0.0	-21	A	Frost last night; attempt tower counting; may have beaver problems; still few fish.
18-Aug	1830	C	O	220° @ 2-3	14	1131	10	8	15	9	0.0	-21	B	Continuous rain; pump water from boats; water remains constant but large trees beginning to pass site
19-Aug	2000	B	O/B	350° @ 0-1	8	2157	9	7	19	14	0.0	-21	A	Intermittent rain; group of about 20 people canoed by - reported seeing 4-5 salmon ~10 mi upstream.
20-Aug	1930	A	B	0° @ 0-1	6	1627	10	7	22	13	0.0	-21	A	Pumped rain water from boat.
21-Aug	1930	A	B	10° @ 3-5	14	1847	11	6	23	11	0.0	-21	A	Family of loons (5) swimming around xducer this AM; beaver may have caused false cts in sector 4.
22-Aug	1900	A	B	70° @ 4-6	18	1130	10	6	23	11	14.0	-7	A	Loons swimming by all day; lots'o bear sign (griz & black) south end bar; something dug in outhouse pit
23-Aug	1900	A	B	0° @ 0	12	2343	10	1	21	11	5.0	-2	B	2nd canoe group stopped - saw 1 salmon upstream; all subsistence fishing closed in Yukon.
24-Aug	1800	A	B	320° @ 1-2	11	1734	10	3	22	11	-1.0	-3	B	Loons still present today.
25-Aug	1745	B	O	10° @ 8-12	24	1616	8	5	8	1	-6.0	-9	B	Wind blew tower over - realm xducer; snow flurries this AM; kayakers reported on salmon upstream.
26-Aug	2100	E	O	240° @ 0	17	1751	9	1	14	8	-2.0	-11	A	Bear false-charged Paul on way to last midnight calibration; thus 0001 & 0300-h calibrations skipped.
27-Aug	2045	A	C	0° @ 0	11	1332	9	1	22	8	-4.0	-15	A	Northern lights out last night.
28-Aug	2100	A	C	0° @ 0	10	1354	8	-1	26	6	3.0	-12	A	Beaver in vic of xducer this AM; saw no salmon on rd-trip to get firewood; chainsaw recoil broke.
29-Aug	2100	A	C	30° @ 2-4	21	1529	8	2	24	14	-1.0	-13	A	Fixed chainsaw and collected firewood; found one spawned out male chum.
30-Aug	2030	A	C	210° @ 0	14	0234	9	4	27	9	-4.0	-17	B	Lots of fish passing tonight. HTI equipment set up & collecting data.
31-Aug	2100	A	C	70° @ 0	13	1835	9	0	26	8	-1.0	-18	A	Lots of fish passing tonight.
01-Sep	1930	B	O	0° @ 0	9	0911	9		12	11	-2.0	-20	A	Bear near camp @ 2200 h - set off loud motion sensor with woofer
02-Sep	2000	A	B	180° @ 1-2	14	1503	9		-18	10	-3.0	-23	A	Black bear by boats this afternoon; water continues to steadily decline.
03-Sep	2100	A	S	190° @ 0	11	1333	9	-1	23	7	-2.0	-25	A	Black bear by boats again this evening; good fish passage during midnight calibration.
04-Sep	2130	A	S	210° @ 1	9	1505	9	3	22	3	-1.0	-26	A	Low fish passage this morning.
05-Sep	2030	A	O	210° @ 0-1	10	1151	9		17	8	-1.0	-27	A	Moved HTI unit closer to shore; made river profile; cross-talk problems between Bendix & HTI ctrs.
06-Sep	2000	A	O	320° @ 0-1	8	1323	9	0	18	12	-2.0	-29	A	Solved cross-talk problem; Barton/Borba arrive; Barton reported several schools of 50-75 chums dwnstr.
07-Sep	1945	A	B	210° @ 3-4	12	1855	9	-1	20	9	-1.0	-30	B	Fish likely skirting bottom of outer beam (~sec 12+); re-aim xducer & drag target; current extremely slow
08-Sep	2000	A	B	0° @ 1-2	11	1941	8	1	22	10	-1.0	-31	A	all way X-river; river becoming very shallow; project boat motor problems. On 8 Sep, Barton took Pfisterer
09-Sep	2030	A	C	0° @ 0-1	12	1032	8	2	19	4	-1.0	-32	A	and Neilson & crew up/down river to look for potential HTI site; replace solenoid on motor. On 9 Sep,
10-Sep	2030	A	B	10° @ 6-7	16	1155	8	-1	20	9	-1.0	-33	A	help pack HTI gear. On 10 Sep, Barton & HTI crew depart ; hunters may have wounded black bear
11-Sep	2200	B	S	210° @ 1-2	11	0910	8	4	10	6	-1.0	-34	A	near camp. Informed on 11 Sep to terminate counting at midnight on 12 Sep due to shallow river.
12-Sep	2100	B	B	160° @ 0	11	1346	8	2	13	2	0.0	-34	A	Painted outhouse; powered sonar down at midnight.
13-Sep	1240	B	S	220° @ 1-2	6	1219	8	9	17	10			A	Start breaking camp.
Average							9	3	19					

[a] Precipitation code for the preceding 24-hr period: A = None; B = Intermittent rain; C = Continuous rain; D = snow and rain mixed; E = light snowfall; F = Continuous snowfall; G = Thunderstorm w/ or w/o precipitation.

[b] Instantaneous cloudcover code: C = Clear and visibility unlimited (CAVU); S = Scattered (<60%); B = Broken (60-90%); O = Overcast (100%); F = Fog or thick haze or smoke.

[c] Instantaneous water color code: A = Clear; B = Slightly murky or glacial; C = Moderately murky or glacial; D = Heavily murky or glacial; E = Brown, tanic acid stain.

Appendix B. Temporal distribution of daily sonar counts attributed to fall chum salmon in Sheenjek River, 2000.

Hour	08-Aug	09-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
0100	[a]	6	12	4	3	28	0	18	25	8	44	46	27	6	10
0200		2	1	3	3	27	11	20	6	15	40	28	21	21	56
0300		5	17	5	9	2	26	1	12	16	35	18	22	30	6
0400	23	5	17	10	6	9	14	4	15	2	7	26	40	10	11
0500	55.2%	5	16	2	16	6	29	55	9	1	9	44	57	17	27
0600		2	9	18	14	15	2	29	16	2	19	1	35	1	23
0700		16	2	2	25	3	4	9	5	4	31	11	4	0	8
0800		3	2	1	8	6	0	0	31	0	14	25	36	11	2
0900		2	4	9	0	3	10	15	29	10	12	73	32	14	11
1000	0	1	0	0	7	6	12	0	29	2	2	40	2	5	14
1100	0	1	1	6	5	1	2	0	7	0	7	3	0	2	0
1200	0	0	18	0	14	2	0	5	8	5	16	5	1	19	2
1300	0	0	20	0	32	10	11	1	1	9	29	6	4	16	0
1400	0	1	0	18	6	1	0	3	35	9	13	42	3	2	5
1500	0	0	0	1	0	6	3	1	14	13	11	13	5	6	11
1600	0	1	1	8	9	1	13	3	10	12	28	12	3	10	20
1700	0	1	6	8	4	7	3	4	3	17	4	21	52	2	30
1800	0	3	1	32	10	36	12	3	3	23	12	7	5	8	27
1900	4	2	6	5	2	34	0	1	1	29	33	6	19	12	20
2000	0	1	0	0	1	1	1	9	9	18	4	24	12	19	5
2100	1	0	3	0	5	1	9	0	15	16	23	16	7	17	8
2200	4	12	0	10	0	7	3	7	23	10	7	8	5	1	4
2300	0	1	5	3	1	5	8	7	7	36	51	58	11	13	26
2400	10	4	12	5	6	20	3	6	29	30	40	27	1	93	27
	42	74	153	150	186	237	176	201	342	287	491	560	404	335	353
	0.2%	0.4%	0.8%	0.8%	1.0%	1.3%	0.9%	1.1%	1.8%	1.5%	2.6%	3.0%	2.2%	1.8%	1.9%

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Hour	23-Aug	24-Aug	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep
0100	26	17	2	53	39	10	10	20	32	25	55	81	114	54	62
0200	17	30	26	17	32	26	41	17	31	54	40	32	77	65	58
0300	30	18	13	24	45	23	29	92	79	78	50	86	86	74	42
0400	18	16	12	20	38	39	61	94	67	85	41	71	119	104	54
0500	38	10	9	12	12	28	48	121	63	96	28	68	84	94	48
0600	11	20	7	26	9	58	45	58	39	49	50	50	96	59	68
0700	32	28	2	7	19	7	10	20	15	5	54	45	52	47	25
0800	27	9	2	2	5	25	25	71	14	20	33	16	32	97	15
0900	8	22	2	5	2	20	28	22	18	12	65	1	14	40	32
1000	3	14	1	2	0	0	0	17	38	8	1	2	2	33	16
1100	1	2	1	0	0	1	1	5	6	15	18	4	1	8	13
1200	0	4	0	0	11	23	7	8	2	9	5	8	3	14	2
1300	2	1	47	4	21	36	7	24	11	3	12	4	1	55	4
1400	0	1	18	8	47	35	2	9	5	1	19	4	17	6	9
1500	4	38	7	12	52	22	22	4	15	0	8	7	4	3	3
1600	19	17	29	12	17	5	6	0	5	2	12	0	2	0	6
1700	5	20	19	6	16	0	16	9	4	2	4	8	4	1	11
1800	24	2	5	22	15	2	6	28	1	1	8	5	2	6	7
1900	9	4	9	0	5	0	12	20	22	7	2	3	27	2	11
2000	0	1	19	35	5	2	1	9	1	6	12	10	2	26	17
2100	9	0	2	27	56	18	27	11	4	19	47	37	17	47	2
2200	9	9	23	15	55	19	89	37	34	25	33	27	119	52	14
2300	15	18	15	46	27	42	22	59	30	23	83	64	83	34	36
2400	34	6	51	14	43	43	29	26	22	38	75	71	53	60	45
	341	307	321	369	571	484	544	781	558	583	755	704	1,011	981	600
	1.8%	1.6%	1.7%	2.0%	3.1%	2.6%	2.9%	4.2%	3.0%	3.1%	4.0%	3.8%	5.4%	5.3%	3.2%

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Appendix B. (p 3 of 3)

Hour	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep	12-Sep	Total [a]	Percent
0100	55	89	65	93	42	22	1,203	0.065
0200	133	74	61	65	49	46	1,245	0.067
0300	34	96	59	45	61	46	1,314	0.071
0400	99	63	72	66	74	98	1,487	0.080
0500	68	75	69	87	83	83	1,517	0.082
0600	68	96	20	52	63	48	1,178	0.063
0700	69	101	15	38	27	38	780	0.042
0800	77	29	59	58	50	54	859	0.046
0900	33	54	30	8	25	20	685	0.037
1000	7	38	22	17	78	24	443	0.024
1100	4	5	3	2	15	3	143	0.008
1200	14	6	1	6	18	1	237	0.013
1300	6	5	26	2	3	1	414	0.022
1400	4	49	29	14	2	10	427	0.023
1500	5	37	17	3	3	5	355	0.019
1600	3	10	5	8	3	11	303	0.016
1700	25	131	5	8	5	27	488	0.026
1800	5	160	5	4	5	9	504	0.027
1900	22	5	3	5	0	5	343	0.018
2000	41	30	12	5	15	10	363	0.020
2100	23	169	40	49	17	26	767	0.041
2200	53	83	74	91	23	48	1,029	0.055
2300	132	69	45	119	25	55	1,274	0.068
2400	108	44	48	86	17	36	1,252	0.067
							18,610 [a]	100%
	1,088	1,518	785	931	703	726	18,652 [c]	
	5.8%	8.1%	4.2%	5.0%	3.8%	3.9%		

[a] This total includes only days with 24-hour counts (9 Aug through 12 Sep).

[b] Estimated passage for this block of time using average hourly distribution for the season.

[c] Total estimated passage includes expanded counts on 8 August.

Appendix C. Field calibrations for 1985-model Bendix sonar salmon counter, Sheenjek River 2000.

Date	Time Start	Duration	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
10-Aug	26	17	4	4	1.000	0.400	1.5	98.5	100.0	14
	1803	15	0	0	--	0.400	1.5	98.5	100.0	0
11-Aug	1	15	0	0	--	0.400	1.5	98.5	100.0	0
	603	15	4	0	--	0.500	1.5	98.5	100.0	16
	1101	15	4	6	0.667	0.500	1.5	98.5	100.0	16
	1732	28	12	13	0.923	0.500	1.5	98.5	100.0	26
	2107	15	0	0	--	0.500	1.5	98.5	100.0	0
12-Aug	9	15	6	2	3.000	0.500	1.5	98.5	100.0	24
	720	15	0	0	--	0.500	1.5	98.5	100.0	0
	1110	15	0	0	--	0.500	1.5	98.5	100.0	0
	1603	15	0	0	--	0.500	1.5	98.5	100.0	0
	2103	15	0	0	--	0.500	1.5	98.5	100.0	0
13-Aug	3	17	2	0	--	0.500	1.5	98.5	100.0	7
	608	15	0	0	--	0.500	1.5	98.5	100.0	0
	1101	15	0	0	--	0.500	1.5	98.5	100.0	0
	1613	15	0	0	--	0.500	1.5	98.5	100.0	0
	2101	15	0	0	--	0.500	1.5	98.5	100.0	0
14-Aug	5	15	0	0	--	0.500	1.5	98.5	100.0	0
	620	15	0	0	--	0.500	1.5	98.5	100.0	0
	1106	15	1	0	--	0.500	1.5	98.5	100.0	4
	1615	18	4	3	1.333	0.500	1.5	98.5	100.0	13
	2104	15	0	0	--	0.500	1.5	98.5	100.0	0
15-Aug	4	15	5	9	0.556	0.500	1.5	98.5	100.0	20
	633	15	10	8	1.250	0.500	1.5	98.5	100.0	40
	1101	15	0	0	--	0.500	1.5	98.5	100.0	0
	1732	17	2	2	1.000	0.500	1.5	98.5	100.0	7
	2106	16	0	0	--	0.500	1.5	87.5	89.0	0
	2340	20	3	2	1.500	0.500	1.5	87.5	89.0	9
16-Aug	637	15	0	0	--	0.500	1.5	87.5	89.0	0
	1101	15	2	1	2.000	0.500	1.5	87.5	89.0	8
	1610	15	3	1	3.000	0.500	1.5	87.5	89.0	12
	2116	15	7	5	1.400	0.500	1.5	87.5	89.0	28
17-Aug	5	15	0	0	--	0.500	1.5	87.5	89.0	0
	613	16	1	1	1.000	0.500	1.5	87.5	89.0	4
	1102	16	1	1	1.000	0.500	1.5	87.5	89.0	4
	1601	21	6	3	2.000	0.500	1.5	87.5	89.0	17
	2101	15	2	3	0.667	0.400	1.5	87.5	89.0	8
	2315	44	24	27	0.889	0.400	1.5	87.5	89.0	33
18-Aug	702	28	4	4	1.000	0.400	1.5	87.5	89.0	9
	1105	15	2	0	--	0.400	1.5	87.5	89.0	8
	1608	16	4	2	2.000	0.400	1.5	87.5	89.0	15
	2103	15	2	0	--	0.400	1.5	87.5	89.0	8
19-Aug	1	15	0	0	--	0.400	1.5	87.5	89.0	0
	701	15	0	0	--	0.400	1.5	87.5	89.0	0
	1115	20	0	0	--	0.400	1.5	87.5	89.0	0
	1621	20	7	7	1.000	0.400	1.5	87.5	89.0	21
	2101	15	0	0	--	0.400	1.5	87.5	89.0	0
	2318	42	22	20	1.100	0.400	1.5	87.5	89.0	31
20-Aug	617	25	0	0	--	0.400	1.5	87.5	89.0	0
	1110	15	0	0	--	0.400	1.5	87.5	89.0	0
	1540	15	2	2	1.000	0.400	1.5	87.5	89.0	8
	2103	15	2	1	2.000	0.400	1.5	87.5	89.0	8
21-Aug	5	15	3	2	1.500	0.400	1.5	87.5	89.0	12
	340	19	4	4	1.000	0.400	1.5	87.5	89.0	13
	707	23	0	0	--	0.400	1.5	87.5	89.0	0
	1118	20	9	14	0.643	0.400	1.5	87.5	89.0	27
	1530	20	6	5	1.200	0.400	1.5	87.5	89.0	18
	1601	15	0	0	--	0.400	1.5	87.5	89.0	0
	2105	15	1	0	--	0.400	1.5	87.5	89.0	4
22-Aug	5	15	5	5	1.000	0.400	1.5	87.5	89.0	20
	332	16	0	0	--	0.400	1.5	87.5	89.0	0
	622	18	5	7	0.714	0.400	1.5	87.5	89.0	17
	1108	20	0	0	--	0.400	1.5	87.5	89.0	0
	1600	15	1	1	1.000	0.400	1.5	87.5	89.0	4
	2103	15	0	0	--	0.400	1.5	87.5	89.0	0

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Appendix C. (page 2 of 3)

Date	Time Start	Duration	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
23-Aug	8	30	19	29	0.655	0.400	1.5	87.5	89.0	38
	323	15	0	0	--	0.400	1.5	87.5	89.0	0
	621	21	3	3	1.000	0.400	1.5	87.5	89.0	9
	1118	16	0	0	--	0.400	1.5	87.5	89.0	0
	1601	15	4	3	1.333	0.400	1.5	87.5	89.0	16
	2101	15	1	0	--	0.400	1.5	87.5	89.0	4
24-Aug	4	15	0	0	--	0.400	1.5	87.5	89.0	0
	301	15	3	3	1.000	0.400	1.5	87.5	89.0	12
	637	18	1	1	1.000	0.400	1.5	87.5	89.0	3
	1122	15	0	0	--	0.400	1.5	87.5	89.0	0
	1601	15	5	7	0.714	0.400	1.5	87.5	89.0	20
	2104	15	0	0	--	0.400	1.5	87.5	89.0	0
	2311	48	7	7	1.000	0.400	1.5	87.5	89.0	9
25-Aug	328	16	7	9	0.778	0.400	1.5	87.5	89.0	26
	645	17	0	0	--	0.400	1.5	87.5	89.0	0
	1131	15	0	0	--	0.400	1.5	87.5	89.0	0
	1515	15	4	6	0.667	0.400	1.5	87.5	89.0	16
	2101	15	0	0	--	0.400	1.5	87.5	89.0	0
26-Aug	612	15	1	1	1.000	0.400	1.5	87.5	89.0	4
	1118	17	0	0	--	0.400	1.5	87.5	89.0	0
	1601	15	4	5	0.800	0.400	1.5	87.5	89.0	16
	1830	15	6	9	0.667	0.400	1.5	87.5	89.0	24
27-Aug	8	16	0	1	--	0.400	1.5	87.5	89.0	0
	342	30	15	19	0.789	0.400	1.5	87.5	89.0	30
	614	15	1	1	1.000	0.400	1.5	87.5	89.0	4
	1104	15	0	0	--	0.400	1.5	87.5	89.0	0
	1601	15	0	2	--	0.400	1.5	87.5	89.0	0
	2105	15	0	0	--	0.400	1.5	87.5	89.0	0
28-Aug	10	15	8	7	1.143	0.400	1.5	87.5	89.0	32
	345	30	15	23	0.652	0.400	1.5	87.5	89.0	30
	645	15	6	6	1.000	0.500	1.5	87.5	89.0	24
	1101	15	11	10	1.100	0.500	1.5	87.5	89.0	44
	1501	15	0	0	--	0.500	1.5	87.5	89.0	0
	2101	15	3	6	0.500	0.500	1.5	87.5	89.0	12
29-Aug	5	15	9	8	1.125	0.500	1.5	87.5	89.0	36
	328	30	31	46	0.674	0.500	1.5	87.5	89.0	62
	642	18	11	15	0.733	0.500	1.5	87.5	89.0	37
	1125	15	2	2	1.000	0.600	1.5	87.5	89.0	8
	1530	15	4	4	1.000	0.600	1.5	87.5	89.0	16
	2030	15	2	1	2.000	0.600	1.5	87.5	89.0	8
30-Aug	13	15	11	8	1.375	0.600	1.5	87.5	89.0	44
	323	30	30	30	1.000	0.600	1.5	87.5	89.0	60
	610	15	4	2	2.000	0.600	1.5	87.5	89.0	16
	1101	15	1	1	1.000	0.600	1.5	87.5	89.0	4
	1601	15	0	0	--	0.600	1.5	87.5	89.0	0
	2101	30	60	60	1.000	0.600	1.5	87.5	89.0	120
31-Aug	11	15	6	8	0.750	0.600	1.5	87.5	89.0	24
	321	30	31	41	0.756	0.600	1.5	87.5	89.0	62
	631	15	0	0	--	0.600	1.5	87.5	89.0	0
	1120	15	2	1	2.000	0.600	1.5	87.5	89.0	8
	1601	15	2	0	--	0.600	1.5	87.5	89.0	8
	2101	15	4	3	1.333	0.600	1.5	87.5	89.0	16
01-Sep	5	15	5	5	1.000	0.600	1.5	87.5	89.0	20
	502	16	0	0	--	0.600	1.5	87.5	89.0	0
	605	15	0	0	--	0.600	1.5	87.5	89.0	0
	1127	30	5	7	0.714	0.600	1.5	87.5	89.0	10
	1405	15	3	0	--	0.680	1.5	87.5	89.0	12
	2105	15	1	0	--	0.680	1.5	87.5	89.0	4
02-Sep	10	30	52	46	1.130	0.600	1.5	87.5	89.0	104
	311	30	25	31	0.806	0.600	1.5	87.5	89.0	50
	640	15	9	22	0.409	0.600	1.5	87.5	89.0	36
	701	12	1	1	1.000	0.625	1.5	87.5	89.0	5
	1130	18	0	0	--	0.625	1.5	87.5	89.0	0
	1520	40	12	10	1.200	0.625	1.5	87.5	89.0	18
	2122	30	36	45	0.800	0.625	1.5	87.5	89.0	72

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Date	Time Start	Duration	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
03-Sep	10	30	51	45	1.133	0.625	1.5	87.5	89.0	102
	310	30	40	39	1.026	0.625	1.5	87.5	89.0	80
	605	15	4	5	0.800	0.625	1.5	87.5	89.0	16
	1101	15	0	0	--	0.625	1.5	87.5	89.0	0
	1401	15	1	0	--	0.625	1.5	87.5	89.0	4
	2105	15	0	0	--	0.625	1.5	87.5	89.0	0
04-Sep	3	30	58	52	1.115	0.625	1.5	87.5	89.0	116
	327	30	43	42	1.024	0.625	1.5	87.5	89.0	86
	709	17	1	4	0.250	0.625	1.5	87.5	89.0	4
	1113	16	4	2	2.000	0.625	1.5	87.5	89.0	15
	1530	30	1	1	1.000	0.625	1.5	87.5	89.0	2
	2130	30	34	29	1.172	0.625	1.5	87.5	89.0	68
05-Sep	4	30	41	38	1.079	0.625	1.5	87.5	89.0	82
	305	30	60	67	0.896	0.625	1.5	87.5	89.0	120
	625	30	20	23	0.870	0.625	1.5	87.5	89.0	40
	1137	16	5	7	0.714	0.625	1.5	87.5	89.0	19
	1605	15	0	0	--	0.625	1.5	87.5	89.0	0
	2101	15	0	0	--	0.625	1.5	87.5	89.0	0
06-Sep	12	30	28	34	0.824	0.625	1.5	87.5	89.0	56
	505	30	60	151	0.397	0.625	1.5	87.5	89.0	120
	645	15	4	4	1.000	0.825	1.5	87.5	89.0	16
	1101	17	0	0	--	0.825	1.5	87.5	89.0	0
	1830	15	2	0	--	0.825	1.5	87.5	89.0	8
	2135	15	3	1	3.000	0.825	1.5	87.5	89.0	12
07-Sep	3	40	43	31	1.387	0.825	1.5	87.5	89.0	65
	115	15	34	22	1.545	0.625	1.5	87.5	89.0	136
	203	15	12	2	6.000	0.625	1.5	87.5	89.0	48
	305	15	37	25	1.480	0.625	1.5	87.5	89.0	148
	630	15	3	2	1.500	0.625	1.5	87.5	89.0	12
	1124	15	5	2	2.500	0.625	1.5	87.5	89.0	20
	1535	15	4	0	--	0.625	1.5	87.5	89.0	16
	2100	15	9	2	4.500	0.625	1.5	87.5	89.0	36
08-Sep	25	30	64	62	1.032	0.625	1.5	88.5	90.0	128
	305	30	33	30	1.100	0.625	1.5	88.5	90.0	66
	640	30	25	26	0.962	0.625	1.5	88.5	90.0	50
	1111	15	3	0	--	0.625	1.5	88.5	90.0	12
	1830	15	1	0	--	0.625	1.5	88.5	90.0	4
	2245	15	5	6	0.833	0.625	1.5	88.5	90.0	20
09-Sep	29	30	30	30	1.000	0.625	1.5	88.5	90.0	60
	215	15	8	6	1.333	0.625	1.5	88.5	90.0	32
	320	30	37	41	0.902	0.625	1.5	88.5	90.0	74
	644	15	5	4	1.250	0.625	1.5	88.5	90.0	20
	1048	15	0	0	--	0.625	1.5	88.5	90.0	0
	1740	15	2	2	1.000	0.625	1.5	88.5	90.0	8
	2040	18	7	5	1.400	0.625	1.5	88.5	90.0	23
10-Sep	34	25	47	55	0.855	0.625	1.5	88.5	90.0	113
	318	30	27	49	0.551	0.625	1.5	88.5	90.0	54
	645	30	24	40	0.600	0.650	1.5	88.5	90.0	48
	1103	15	1	0	--	0.650	1.5	88.5	90.0	4
	1648	15	0	0	--	0.650	1.5	88.5	90.0	0
	2035	17	6	4	1.500	0.650	1.5	88.5	90.0	21
11-Sep	15	32	31	29	1.069	0.650	1.5	88.5	90.0	58
	330	30	41	43	0.953	0.650	1.5	88.5	90.0	82
	635	30	10	17	0.588	0.650	1.5	88.5	90.0	20
	1131	15	2	2	1.000	0.650	1.5	88.5	90.0	8
	1535	15	0	0	--	0.650	1.5	88.5	90.0	0
	2211	25	14	16	0.875	0.650	1.5	88.5	90.0	34
	2344	15	7	23	0.304	0.650	1.5	88.5	90.0	28
12-Sep	325	30	54	45	1.200	0.650	1.5	88.5	90.0	108
	645	30	14	20	0.700	0.650	1.5	88.5	90.0	28
	1245	15	2	0	--	0.650	1.5	88.5	90.0	8
	1530	20	2	3	0.667	0.650	1.5	88.5	90.0	6
	2101	15	8	11	0.727	0.650	1.5	88.5	90.0	32
13-Sep	3	30	21	28	0.750	0.650	1.5	88.5	90.0	42
Total	194	3,733	1,803	1,947	0.9260					

Appendix D. Sonar-estimated escapement of fall chum salmon in the Sheenjek River, 1986-2000.

Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Date
30-Jul											670					30-Jul
31-Jul											706					31-Jul
01-Aug											541					01-Aug
02-Aug											793					02-Aug
03-Aug											685					03-Aug
04-Aug											577					04-Aug
05-Aug											469					05-Aug
06-Aug											724					06-Aug
07-Aug									146		918					07-Aug
08-Aug								45	75		1,554				42	08-Aug
09-Aug						255	136	95	112		930	114			74	09-Aug
10-Aug						301	172	256	38	964	963	248		32	153	10-Aug
11-Aug						179	102	143	214	882	479	332		60	150	11-Aug
12-Aug						173	272	217	243	468	315	306		37	186	12-Aug
13-Aug						178	216	227	328	344	315	421		76	237	13-Aug
14-Aug						282	337	175	215	359	903	473		41	176	14-Aug
15-Aug						551	670	291	261	1,045	762	420		43	201	15-Aug
16-Aug	1,010 [a]					521	571	346	333	863	753	534		70	342	16-Aug
17-Aug	68					418	1,100	367	378	891	602	341	56	86	287	17-Aug
18-Aug	345					591	1,570	245	524	1,172	724	307	98	101	491	18-Aug
19-Aug	769					668	1,003	316	497	1,656	753	430	63	290	560	19-Aug
20-Aug	1,576		4,340 [a]			446	2,347	466	257	2,105	1,662	354	35	217	404	20-Aug
21-Aug	1,178		961		15,550 [a]	1,012	1,767	117	594	2,632	1,594	291	23	224	335	21-Aug
22-Aug	3,023		1,027		1,718	1,990	1,353	124	642	2,677	1,178	506	27	59	353	22-Aug
23-Aug	1,177		884	20,000 [b]	1,825	1,754	1,189	157	1,673	3,525	2,472	688	58	138	341	23-Aug
24-Aug	1,733	13,181 [a]	744	2,685	1,940	889	1,390	177	1,035	6,301	11,459	996	43	279	307	24-Aug
25-Aug	5,374	168	810	2,321	1,620	1,591	1,147	156	848	4,745	9,966	1,059	95	730	321	25-Aug
26-Aug	4,875	314	1,528	1,392	1,047	1,684	893	248	791	4,445	7,034	1,179	93	395	369	26-Aug
27-Aug	3,712	795	1,203	1,129	1,055	1,846	1,032	208	2,934	6,358	4,545	2,329	59	645	571	27-Aug
28-Aug	4,633	951	1,087	1,009	1,337	1,508	778	296	3,677	4,839	5,778	2,320	114	676	484	28-Aug
29-Aug	5,150	993	756	733	1,605	1,196	463	369	4,082	6,842	11,457	1,884	47	410	544	29-Aug
30-Aug	4,336	1,400	914	1,265	881	905	943	647	4,487	7,436	12,249	2,067	143	247	781	30-Aug
31-Aug	3,889	1,639	1,512	933	1,609	1,676	840	999	5,472	6,517	12,522	2,250	274	207	558	31-Aug
01-Sep	2,101	3,937	1,548	1,598	1,570	2,164	835	1,045	6,912	8,782	7,597	2,433	248	115	583	01-Sep
02-Sep	2,230	3,295	1,492	1,759	1,695	1,749	830	632	7,196	5,856	6,326	2,616	234	164	755	02-Sep
03-Sep	1,819	7,585	2,203	1,739	1,002	1,808	1,217	2,092	5,918	7,049	6,457	2,799	117	203	704	03-Sep
04-Sep	2,406	11,386	1,991	2,819	1,159	2,026	2,023	2,557	3,666	4,185	5,113	3,404	301	327	1,011	04-Sep
05-Sep	1,645	10,962	1,309	2,571	955	2,476	2,093	2,097	2,832	4,525	5,214	3,352	118	186	981	05-Sep
06-Sep	2,265	5,439	1,286	2,936	1,339	1,241	3,154	1,673	2,952	6,084	5,763	2,761	277	422	600	06-Sep
07-Sep	2,849	10,182	1,542	4,210	1,259	3,490	4,200	2,414	3,928	6,852	7,871	2,904	254	416	1,088	07-Sep
08-Sep	2,760	11,122	1,297	3,581	1,071	2,680	3,092	2,720	3,587	6,318	6,333	4,842	590	742	1,518	08-Sep
09-Sep	2,469	8,487	1,443	4,858	1,411	4,201	4,274	1,300	2,598	5,403	3,718	2,849	412	555	785	09-Sep
10-Sep	1,131	5,561	1,073	4,051	854	3,541	3,209	580	2,341	4,957	4,364	1,995	416	594	931	10-Sep
11-Sep	1,461	4,882	696	3,551	1,746	2,236	3,815	401	3,382	6,758	7,409	1,971	594	514	703	11-Sep
12-Sep	2,500	6,294	340	3,414	1,726	3,136	3,816	465	2,796	6,597	4,735	2,323	722	470	726	12-Sep
13-Sep	1,751	5,831	673	3,227	1,803	3,139	4,047	373	3,066	6,561	6,974	3,602	1,348	589	shallow	13-Sep
14-Sep	2,866	4,485	703	2,797	2,196	3,145	6,347	351	3,294	6,184	5,944	2,983	1,120	343	water	14-Sep
15-Sep	2,290	3,963	1,037	2,027	2,065	4,823	4,289	197	3,522	10,161	5,406	3,294	1,201	309		15-Sep
16-Sep	1,099	4,118	1,275	2,498	2,175	4,240	3,232	407	4,764	9,026	7,871	2,376	2,850	303		16-Sep
17-Sep	1,488	4,763	1,943	3,035	2,867	2,729	2,473	1,176	4,413	9,097	11,181	2,379	2,492	430		17-Sep
18-Sep	1,481	4,326	1,637	2,090	1,909	2,734	2,158	1,053	3,249	8,525	7,850	2,101	2,607	542		18-Sep
19-Sep	1,548	2,635	1,209	1,839	2,020	3,119	2,406	1,359	6,500	8,468	10,474	2,096	2,526	294		19-Sep
20-Sep	679	3,160	1,151	2,321	2,372	3,319	1,007	1,192	7,583	8,065	6,755	1,613	2,692	290		20-Sep
21-Sep	704	3,223	716	1,273	2,444	2,461	early	3,382	5,287	9,590	6,170	1,612	2,756	389		21-Sep
22-Sep	577	1,988	743	1,384	2,667	1,924	freezeup	2,005	6,520	5,943	3,924	2,249	2,120	533		22-Sep
23-Sep	587	2,878	583	2,434	1,848	2,071		1,803	5,153	6,518	4,486	2,020	1,594	436		23-Sep
24-Sep	653	3,324	522	2,965	1,819	1,430		1,655	4,523	6,432	1,902		811			24-Sep
25-Sep			365	2,672	1,923			1,083	3,607	6,853			529			25-Sep
26-Sep			344		1,392			1,158	3,458				430			26-Sep
27-Sep			319		1,478			568	3,600				487			27-Sep
28-Sep					798			497	4,062				736		11,432 [c]	28-Sep
29-Sep													587			29-Sep
30-Sep													661			30-Sep
Totals	84,207	153,267	45,206	99,116	77,750	86,496	78,808	42,922	150,565	241,855	246,889	80,423	33,058	14,229	30,084 [c]	

[a] Early portion of Sheenjek River fall chum salmon run estimated from run timing and entry pattern observed in the Chandalar River (Barton 1995).
[b] Early portion of Sheenjek River fall chum salmon run estimated from aerial survey (Barton 1995).
[c] Latter portion of run estimate based upon average run timing from 1986 thorugh 1999.

Appendix E. Cumulative proportion of Sheenjek River sonar counts, 1986-2000.

Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Date	
30-Jul											0.00					30-Jul	
31-Jul											0.01					31-Jul	
01-Aug											0.01					01-Aug	
02-Aug											0.01					02-Aug	
03-Aug											0.01					03-Aug	
04-Aug											0.02					04-Aug	
05-Aug											0.02					05-Aug	
06-Aug											0.02					06-Aug	
07-Aug									0.00		0.02					07-Aug	
08-Aug								0.00	0.00	0.00	0.03	0.00	0.00		0.00	08-Aug	
09-Aug						0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00		0.01	09-Aug	
10-Aug						0.00	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.00	0.01	10-Aug	
11-Aug						0.01	0.01	0.01	0.00	0.01	0.04	0.01	0.00	0.01	0.02	11-Aug	
12-Aug						0.01	0.01	0.02	0.01	0.01	0.04	0.01	0.00	0.01	0.03	12-Aug	
13-Aug						0.01	0.01	0.02	0.01	0.01	0.04	0.02	0.00	0.01	0.05	13-Aug	
14-Aug						0.01	0.02	0.03	0.01	0.01	0.05	0.02	0.00	0.02	0.05	14-Aug	
15-Aug						0.02	0.02	0.03	0.01	0.02	0.05	0.03	0.00	0.02	0.07	15-Aug	
16-Aug	0.01[a]					0.03	0.03	0.04	0.01	0.02	0.05	0.04	0.00	0.03	0.08	16-Aug	
17-Aug	0.01					0.03	0.05	0.05	0.02	0.02	0.06	0.04	0.00	0.03	0.10	17-Aug	
18-Aug	0.02					0.04	0.07	0.06	0.02	0.03	0.06	0.04	0.00	0.04	0.13	18-Aug	
19-Aug	0.03					0.04	0.08	0.06	0.02	0.04	0.06	0.05	0.01	0.06	0.16	19-Aug	
20-Aug	0.04		0.10[a]			0.05	0.11	0.07	0.02	0.04	0.07	0.05	0.01	0.07	0.18	20-Aug	
21-Aug	0.06		0.12		0.20[a]	0.06	0.13	0.08	0.03	0.06	0.07	0.06	0.01	0.09	0.20	21-Aug	1986-99
22-Aug	0.09		0.14		0.22	0.08	0.15	0.08	0.03	0.07	0.08	0.06	0.01	0.09	0.21	22-Aug	Average
23-Aug	0.11		0.16	0.20[b]	0.25	0.10	0.16	0.08	0.04	0.08	0.09	0.07	0.01	0.10	0.23	23-Aug	
24-Aug	0.13	0.09[a]	0.18	0.23	0.27	0.12	0.18	0.09	0.05	0.11	0.14	0.08	0.01	0.12	0.25	24-Aug	0.13
25-Aug	0.19	0.09	0.19	0.25	0.29	0.13	0.19	0.09	0.06	0.13	0.18	0.10	0.02	0.17	0.27	25-Aug	0.15
26-Aug	0.25[c]	0.09	0.23	0.27	0.30	0.15	0.21	0.10	0.06	0.15	0.20	0.11	0.02	0.20	0.29	26-Aug	0.17
27-Aug	0.29	0.09	0.25	0.28	0.32	0.17	0.22	0.10	0.08	0.17	0.22	0.14	0.02	0.25	0.32	27-Aug	0.19
28-Aug	0.35	0.10	0.28	0.29	0.34	0.19	0.23	0.11	0.11	0.19	0.25	0.17	0.02	0.30	0.34	28-Aug	0.21
29-Aug	0.41	0.11	0.30	0.30	0.36	0.21	0.23	0.12	0.13	0.22	0.29	0.19	0.02	0.32	0.37	29-Aug	0.23
30-Aug	0.46	0.12	0.32	0.31	0.37	0.22	0.25	0.13	0.16	0.25	0.34	0.22	0.03	0.34	0.41	30-Aug	0.25
31-Aug	0.51[d]	0.13	0.35	0.32	0.39	0.24	0.26	0.16	0.20	0.28	0.39	0.25	0.04	0.36	0.44	31-Aug	0.27
01-Sep	0.53	0.15	0.38	0.33	0.41	0.26	0.27	0.18	0.24	0.31	0.42	0.28	0.04	0.36	0.47	01-Sep	0.30
02-Sep	0.56	0.17	0.42	0.35	0.43	0.28	0.28	0.19	0.29	0.34	0.45	0.31	0.05	0.38	0.51	02-Sep	0.32
03-Sep	0.58	0.22	0.46	0.37	0.44	0.30	0.29	0.24	0.33	0.37	0.48	0.34	0.06	0.39	0.55	03-Sep	0.35
04-Sep	0.61	0.30	0.51	0.40	0.46	0.32	0.32	0.30	0.36	0.38	0.50	0.39	0.06	0.41	0.61	04-Sep	0.38
05-Sep	0.63	0.37	0.54	0.42	0.47	0.35	0.35	0.35	0.37	0.40	0.52	0.43	0.07	0.43	0.66	05-Sep	0.41
06-Sep	0.66	0.40	0.57	0.45	0.49	0.37	0.39	0.39	0.39	0.43	0.54	0.46	0.08	0.46	0.69	06-Sep	0.43
07-Sep	0.69	0.47	0.60	0.50	0.50	0.41	0.44	0.45	0.42	0.46	0.57	0.50	0.08	0.48	0.75	07-Sep	0.47
08-Sep	0.72	0.54	0.63	0.53	0.52	0.44	0.48	0.51	0.44	0.48	0.60	0.56	0.10	0.54	0.83	08-Sep	0.51
09-Sep	0.75	0.60	0.66	0.58	0.54	0.49	0.53	0.54	0.46	0.50	0.61	0.59	0.11	0.58	0.87	09-Sep	0.54
10-Sep	0.77	0.64	0.68	0.62	0.55	0.53	0.57	0.55	0.48	0.53	0.63	0.62	0.13	0.62	0.92	10-Sep	0.56
11-Sep	0.78	0.67	0.70	0.66	0.57	0.55	0.62	0.56	0.50	0.55	0.66	0.64	0.14	0.65	0.96	11-Sep	0.59
12-Sep	0.81	0.71	0.71	0.69	0.59	0.59	0.67	0.57	0.52	0.58	0.68	0.67	0.17	0.69	1.00	12-Sep	0.62
13-Sep	0.83	0.75	0.72	0.72	0.61	0.63	0.72	0.58	0.54	0.61	0.71	0.72	0.21	0.73	shallow	13-Sep	0.65
14-Sep	0.87	0.78	0.74	0.75	0.64	0.66	0.80	0.59	0.56	0.63	0.73	0.75	0.24	0.75	water	14-Sep	0.68
15-Sep	0.90	0.80	0.76	0.77	0.67	0.72	0.86	0.60	0.58	0.68	0.75	0.80	0.28	0.77		15-Sep	0.71
16-Sep	0.91	0.83	0.79	0.80	0.70	0.77	0.90	0.61	0.62	0.71	0.79	0.83	0.36	0.80		16-Sep	0.74
17-Sep	0.93	0.86	0.83	0.83	0.73	0.80	0.93	0.63	0.64	0.75	0.83	0.85	0.44	0.83		17-Sep	0.78
18-Sep	0.94	0.89	0.87	0.85	0.76	0.83	0.96	0.66	0.67	0.79	0.86	0.88	0.52	0.86		18-Sep	0.81
19-Sep	0.96	0.90	0.90	0.87	0.78	0.87	0.99	0.69	0.71	0.82	0.91	0.91	0.59	0.88		19-Sep	0.84
20-Sep	0.97	0.93	0.92	0.89	0.82	0.91	1.00	0.72	0.76	0.85	0.93	0.93	0.68	0.90		20-Sep	0.87
21-Sep	0.98	0.95	0.94	0.90	0.85	0.93	early	0.80	0.79	0.89	0.96	0.95	0.76	0.93		21-Sep	0.89
22-Sep	0.99	0.96	0.95	0.92	0.88	0.96	freezeup	0.84	0.84	0.92	0.97	0.97	0.82	0.97		22-Sep	0.92
23-Sep	0.99	0.98	0.97	0.94	0.90	0.98		0.88	0.87	0.95	0.99	1.00	0.87	1.00		23-Sep	0.95
24-Sep	1.00	1.00	0.98	0.97	0.93	1.00		0.92	0.90	0.97	1.00		0.90			24-Sep	0.96
25-Sep			0.99	1.00	0.95			0.95	0.93	1.00			0.91			25-Sep	
26-Sep			0.99		0.97			0.98	0.95				0.93			26-Sep	
27-Sep			1.00		0.99			0.99	0.97				0.94			27-Sep	
28-Sep					1.00			1.00	1.00				0.96			28-Sep	
29-Sep													0.98			29-Sep	
30-Sep													1.00			30-Sep	

[a] Early portion of Sheenjek River fall chum salmon run estimated from run timing and entry pattern observed in the Chandalar River (Barton 1995).
[b] Early portion of Sheenjek River fall chum salmon run estimated from aerial survey (Barton 1995).
[c] Interquartile range and median day of passage(d) are shown for each year.